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The Correlation between the Awareness of the Dangers in Smartphone Radiation and Sleep Quality among High School Students in Thailand

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ABSTRACT: Despite smartphones' critical benefits in several aspects of living in this generation, their emissions of radiation exert profound effects on the physical health of the affected individuals, including heightened risks of cancer as well as increased fibroblast activity of the skin. The aim of this study endeavors to determine the correlation between awareness of the dangers in utilizing smartphones before bed and sleep quality among high school students, to raise consciousness of the perils of smartphone radiation, and to observe sleep qualities among high school students. Through previous research, it was hypothesized that awareness of the dangers in smartphone radiation would negatively impact the sleep quality of the participants due to the negative ramifications of the radiation. To verify whether this also implies an impact on the Thai population, data were collected using a cross-sectional method with random samples of both Thai and international high school students. The information was later analyzed via Statistical Product and Service Solutions (SPSS). The results indicate a robust correlation between dangers in smartphone's radiation and sleep quality ($p = 0.451^{**}$), grade and sleep quality ($p = 0.003^{*}$), and age and sleep quality ($p = 0.002^{*}$). Moreover, a strong correlation between grade and sleep quality, as well as age and sleep quality, can be inferred that grade and age correlate with the amount of stress within individuals, having a negative effect on individuals' sleep quality. Ultimately, this research not only analyzes the correlation in the findings but also aims to raise awareness of potential hazards in smartphone radiation among high school students to enhance their sleep quality.

KEYWORDS: High school students, Smartphone radiation, Sleep quality, Stress.

INTRODUCTION

In this current decade, usage of electronic devices on various platforms, especially smartphones, has increased drastically. Approximately half of Thai students (45.3%) utilized smartphones for longer than 5 hours daily in comparison with Japanese students at 12.8% [1]. Furthermore, according to the January 21 report of Hootsuite and We Are Social, the total number of mobile connections was approximately 91 million, which surpasses the population of Thailand by 130 percent [2]. This numerous usage of smartphones is due to their wide applications, which include communication, entertainment, education, and more.

People who indulge in smartphones often lose track of time, which may lead to insufficient sleep. Sleep can be defined as an active state of unconsciousness produced by the body, where the brain components in the central nervous system are in a state of rest and only reactive primarily to internal stimuli [3]. According to the restorative theory, sleep plays a crucial role in recovering cellular components, supporting bodily functions such as protein synthesis, and neural reorganization. This is evidenced in a study on sleep-mediated memory benefits, where they show how sleep consolidates memory by experimenting with participants on word-pair learning activities [4]. Despite acknowledging the fundamental benefits of sleep, people still neglect the sufficient number of hours for sleep.

With the overutilization of smartphones, various radiations, such as radiofrequency (RF), have been shown to alter the physical health of an individual. Myriad effects from RF exposures include cardiomyopathy, electromagnetic hypersensitivity, and non-thermal induction of reactive oxygen species. Moreover, various studies have linked RF exposure to brain and thyroid cancer [5]. Among international program students who attended university in Bangkok, severe occurrence of eye strain (73%), sleep deprivation, and muscle cramping were the physical consequences from smartphone addiction [6]. Therefore, it is recommended to turn off notifications, keep the phone out of reach at night, and employ grayscale settings [7].

This research intends to illustrate the prevalent neglect in individuals' physical well-being as smartphone usage is prioritized. Furthermore, there is a scarcity of studies focused solely on the sample size of high school students in Bangkok. Thus, through the

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outcomes, we aim to gain deeper insights in these contemporary societal trends as well as initiate a strategic framework for enhancing students' knowledge of the potential hazards involved from the uncontrolled usage of smartphones.

METHODOLOGY

A cross-sectional survey in Thailand was conducted to examine the correlation between awareness of smartphone radiation effects and sleep quality among randomly selected high school students through sleep habits [8]. Utilizing an online Google Forms questionnaire with three sections—general information, sleep quality survey, and assessment questions—we employed a linear rating scale with the following scores: 1 - Strongly disagree, 5 Strongly agree; 1 - Not aware, 5 - Aware ; 1 - Never, 5 - Always. The assessment section gauged agreement, awareness, and frequency. The questionnaire underwent review by two specialists, achieving an Item Objective Congruence (IOC) exceeding 0.5. In a pilot test with 35 participants, SPSS version 29.0.2 determined a reliability of 0.845 using Cronbach's alpha. In the statistical analysis, Pearson's correlation was used to analyze the relationship between sleep quality and awareness of the hazards of smartphone radiation, while one-way ANOVA was used to measure the relationship between grade and sleep quality as well as age and sleep quality in 162 participants.

INSTRUMENT

General Information

1. Gender
2. Which type of school are you currently studying in?
3. Grade
4. Age
5. Where do you charge your phone?
6. How many hours on school days do you usually sleep?
7. How many hours on weekends do you usually sleep per night?
8. What are the potential risks of smartphone radiation to physical health?

Sleep Quality

1. I usually take a long time to fall asleep.
2. I have a sleep disorder; for example, insomnia.
3. I generally consider myself as a bad sleeper.
4. My fatigue isn't relieved after sleep.
5. Poor quality of sleep gives me a headache.
6. Poor quality of sleep makes me feel irritated.
7. Sleepiness interferes with my daily life.
8. Poor quality of sleep makes my memory worse.
9. Poor sleep makes me lose interest in social activities.
10. Poor quality of sleep decreases my ability to think.
11. I would like to sleep more after waking up.
12. Poor quality of sleep makes it hard to concentrate at work.
13. Poor quality of sleep makes me easily tired at work.
14. I am unsatisfied with my sleep.

Awareness of the Dangers in Smartphone Radiation

1. I agree that smartphone radiation impacts my sleep quality negatively.
2. Radio frequency is a type of wave from smartphone radiation.
3. The minimum distance between the user and smartphone should be 15 centimeters for the RF radiation to be harmless while sleeping.
4. I agree that a smartphone emits a lot of radiation when it has a low battery.
5. I agree that smartphone radiation for one hour can cause internal change and increased fibroblast activity of the skin.

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6. Are you aware that in 2011, the World Health Organization noted mobile phone radiation as a possible cause of cancer?
7. Infants aged below 7 years are more at risk from smartphone radiation than adults aged above 50 years.

RESULTS

Table1: General Information

General Information	Frequency	Valid Percent
Gender		
Male	56	34.6
Female	105	64.8
Others	1	.6
Type of School		
Thai School	129	79.6
International School	33	20.4
Grade		
Grade 9	12	7.4
Grade 10	42	25.9
Grade 11	61	37.7
Grade 12	47	29.0
Age		
15 years	27	16.7
16 years	48	29.6
17 years	47	29.0
18 years	25	15.4
19 years	15	9.3

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Charging Location of Smartphone		
On the bed	34	21.0
In your bedroom	108	66.7
Outside your bedroom	20	12.3
Hours (per night) slept during the s chool days		
Less than 5 hours	26	16.0
5-6 hours	69	42.6
6-7 hours	40	24.7
7-8 hours	22	13.6
8-9 hours	4	2.5
More than 9 hours	1	.6
Hours (per night) slept during the weekend		
Less than 5 hours	10	6.2
5-6 hours	18	11.1
6-7 hours	19	11.7
7-8 hours	38	23.5
8-9 hours	41	25.3
More than 9 hours	36	22.2

Table 1 displays the general information of the participants obtained from the first section of the questionnaire. The majority of the participants are female (105 participants, 64.8%), male (56 participants, 34.6%), and others (1 participant, 0.6%). 129 participants study in Thai schools whereas 33 participants study in international schools. Of the 162 participants who are currently in high school, 12 students (7.4%) are in grade 9, 42 students (25.9%) in grade 10, 61 students (37.7%) in grade 11, and 47 students (29.0%) in grade 12. Most of the participants are 16 years old (29.6%), followed by 17 years old (29.0%), 15 years old (16.7%), 18 years old (15.4%), and 19 years old (9.3%), respectively. Of all participants, 34 charged their smartphones on the bed, 108 in the bedroom, and 20 outside the bedroom. Approximately 83.3% of the participants tend to have a period of sleep less than or equal to 7 hours on school days; in contrast, about 71.0% of all participants tend to sleep for more than 7 hours on the weekends.

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Table 2: Distribution of the awareness of health risks from smartphone radiation

Potential risks of smartphone radiation	Frequency
Eye problem	170
Headache	144
Brain cancer	44
Increased stress	100
Sleep Disturbance	129

Table 2 reveals the trend in participants' acknowledgment of potential risks caused by smartphone radiation. As observed from the quantitative data of the survey, eye problems are the most well-known potential risk from smartphone radiation. Potential risks following eye problems include headaches (144 answers) and sleep disturbances (129 answers). It can be inferred that many individuals experience headache and sleep disturbance-related symptoms (dizziness, burning sensations, sleep disorders) [9]. In addition, 100 participants selected increased stress as one of the experienced symptoms, and the least known risk is brain cancer (44 participants).

Table 3. Descriptive statistics (mean and standard deviation)

	N	Mean	Std. Deviation
Quality of Sleep	162	3.40	.69
Awareness of Dangers in Smartphone Radiation	162	3.12	.76

According to Table 3, the mean quality of sleep of all 162 participants is 3.40 with a standard deviation of 0.69. Similarly, the mean awareness of smartphone radiation was 3.12 with a standard deviation of 0.76. The values of the standard deviation, which are less than 1, reveal that most of the quantitative data (obtained from the scale of 1 to 5 in the questionnaire) clump in the middle. Comparing sleep quality and awareness of dangers from smartphone radiation, these values are not much further apart and are evidently very close to each other's numbers. Furthermore, the value of the mean (outward 2.5) reveals that most of the participants assert low sleep quality; however, high knowledge of risks of smartphone radiation.

Table 4: Pearson's correlation

	Quality of Sleep	Awareness of Dangers in Smartphone Radiation	r
Quality of Sleep	Pearson Correlation	1	.451**
	Sig (2-tailed)		< .001
	N	162	162

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According to Table 4, the quality of sleep and awareness of smartphone radiation significantly correlate to each other, with the r value of Pearson correlation at 0.451**, which is a value considerably close to 0.5. The significant (2-tailed) r value is at <0.001, meaning the error percentage is significantly small with a total of 162 responses. Since the r value ranges from the value of -1 to 1, an r value of 0.451** implies a strong correlation between sleep quality and awareness of the dangers of smartphone radiation.

Table 5: One-way ANOVA test; comparing grade and sleep quality

Sleep Quality	Sum of squares	df	Mean Square	F	p
Between Groups	6.367	3	2.122	4.818	.003*
Within Groups	69.600	158	.441		
Total	75.967	161			

According to Table 5, the self awareness of phone radiation between groups means square is at 2.122 and 0.441 for within groups. For sleep quality, the mean square is at 1.951 for between groups and 0.434 for within groups. The F value is at 4.818 and the p-value is at 0.003*.

Table 6: One-way ANOVA table: comparing age and sleep quality

Sleep Quality	Sum of squares	df	Mean Square	F	p
Between Groups	7.804	4	1.951	4.493	.002*
Within Groups	68.164	157	.434		
Total	75.967	161			

According to Table 6, the sleep quality F value is at 4.493 and p-value is at 0.002*. The asterisks on the p-values indicate that age and sleep quality as well as grade and sleep quality are significant to each other.

DISCUSSION

The outcome of our research indicates a strong correlation between the awareness of smartphone radiation effects and sleep quality, supported by Pearson correlation coefficient, r value = 0.451** (Table 4). This shows that students who are not aware of or have minimal awareness of smartphone radiation's effects tend to experience poorer sleep quality compared to those who are aware. One of the rationales behind this relationship may be attributed to the impacts on an individual's anterior pituitary gland, which later contribute to a lowering of cortisol levels, adrenocorticotropic hormone (ACTH), and other hormones [10].

As referred to in Table 2, ophthalmic conditions are considered the most well-known risk caused by smartphone radiation. The rationale behind this may suggest that individuals acknowledge the dangers of blue light, such as the damage to retinal cells and macular degeneration [11]. On the other hand, the least known risk from the radiation is brain cancer. Thus, this result can be inferred that the majority of high school students in Thailand are not aware of the radiation acting as a carcinogen to the brain, from which we can take action in distributing information and promoting awareness about the radiation's role as a carcinogen. The increase in stress level of participants can be supported by an increase of 3.4 in the average stress score from the experiment conducted in the "Journal of Medical Systems" [12].

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Moreover, our research indicates a strong relationship between grade level, age, and sleep quality, as evident in Tables 5 and 6. The data indicates that higher grade levels and older students tend to have poorer sleep quality, which could be potentially caused by increased stress levels and increased academic workload as the grade level increases. According to the American Psychological Association, teens sleeping less than 8 hours reported that stress was the cause, with more than half (53%) feeling sluggish and unable to concentrate in class [13]. Additionally, stress disrupts sleep by significantly increasing cortisol levels during the night, when the cortisol levels should be low to have a quality sleep [14]. As grade levels go up, the stress that comes with increased workload also increases, with almost half of high school students reported to be stressed almost every day in school, and this pattern is also seen in college students who consider themselves to be stressed at a higher than average level [15]. Age, similarly, contributes to poorer sleep quality, as excess physical and emotional distress that increases with age can cause anxiety and muscle stiffness, which eventually leads to poorer sleep quality, according to Bangkok Hospital [16].

The data contributes to a clearer understanding of how increased awareness of the negative effects of phone radiation can help improve students' sleep quality since these two factors show a strong correlation to each other. This illustrates the importance of improving education to increase awareness of the negative effects of smartphone radiation among students. According to the American Academy of Child & Adolescent Psychiatry [17], teens spend up to 9 hours on their electronic devices, and they also absorb what is being spread and taught online—meaning if there are projects or programs spreading knowledge about the negative effects of smartphone radiation as well as ways to prevent it on social media platforms, it is very possible that students will get improved sleep quality as a result of increased awareness.

While our study primarily focuses on the correlation between awareness of smartphone radiation effects and sleep quality, it is beyond the scope of this study to find out the exact causes of the increasingly poor quality of sleep in high school students, as there are various reasons that can depend on the students' environment, which differ for every student who grew up under different conditions, showing the need for more research to improve sleep quality among high school students.

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