

Factors Associated with Headaches in Smartphone Users

Erna Dwi Wahyuni*, Aulathivali Inas Faravida, Ika Nur Pratiwi

Abstract ---The use of a smartphone has increased significantly and this can affect a person's health, including the incidence of headaches. This study aimed to analyze the factors that can trigger the incidence of headaches in smartphone users. The design of this study was descriptive analytics with a cross-sectional approach. A simple random sampling technique was chosen to get respondents according to the inclusion criteria. The population was 704 college students in the Faculty of Nursing Universitas Airlangga, with a total number of respondents of 176 students. The independent variables were the duration of smartphone use, frequency of smartphone use, and radiation level of the smartphone that is used. The dependent variable was the incidence of headaches. The instrument used was a questionnaire about smartphone use and a questionnaire about headaches characteristics. The data were analyzed using Spearman's Rank Correlation Coefficient with $p = 0.05$. The findings revealed a correlation between the duration of smartphone use ($p = 0.000$) and the incidence of headaches, so is the frequency of smartphone use ($p = 0.004$). And there was no correlation between the radiation level of the smartphone that is used ($p = 0.978$) and the incidence of headaches. The factors that can increase the incidence of headache in smartphone users were the duration and frequency of smartphone use.

Keywords--- duration, frequency, headaches, radiation level, smartphone

I. INTRODUCTION

Smartphones are an intrinsic part that is now vital in the life of modern society, helping individuals interact with other individuals throughout the world [1]. Smartphones have certainly become a necessity in one's life, but despite all their benefits, they also have an impact that is not always good. The use of smartphones can disrupt a person's health status, smartphones can also trigger the occurrence of headaches in students[2]. Several factors can cause headaches, namely the duration, intensity of smartphone usage and the radiation level of the smartphone used. However, the correlation between duration, the intensity of smartphone use and smartphone radiation level used in the incidence of headache in smartphone users still needs to be proven.

Headaches are the most common complaints in the clinic and neurology [3]. Headaches are reported to be the third cause of disability in the world [4]. According to the World Health Organization [5], the prevalence of headaches in adults is around 50%. A headache for 15 days or more every month is experienced by 1.7 - 4% of the adult population in the world. Headaches associated with smartphones often occur in students with a total of 460 students in South Kamataka, complaining of headaches when they use their smartphone too long[6]. The incidence of headaches in Indonesia, especially in the Faculty of Medicine at Sam Ratulangi University, was reported for as many as 176 students with 74.4% being female, 25.6% male with an average use of 5-7 hours [2].

Faculty of Nursing, Universitas Airlangga, Surabaya, Indonesia.

Corresponding author
Erna Dwi Wahyuni
Email: erna-d-w@fkip.unair.ac.id

In a preliminary study conducted on 27-28 February 2019 at Airlangga University, 15 respondents admitted they often experience headaches when they have been struggling with their smartphone for too long with an average use of about 10 hours per day. 7 people complained of headaches felt on one side, and 8 people experienced it on two sides. The reason they use smartphones is to socialize in the cyberspace by using chat applications, exploring social media, and looking for literature related to lectures. They also complained about several other problems related to the duration of smartphone use, namely hot eyes, watery eyes, and tired eyes. The smartphones used vary with varying degrees of radiation.

Students use smartphones to socialize, listen to music, play games, and search the literature for lectures [2]. Smartphones can do many things and this makes their users unable to break away from these devices[7]. However, there are many side effects in case of excessive use. Some of these include dry eyes, blurred vision, headaches, neck and back pain, and the worst depression [8]. Smartphone use is too heavy and can often cause headaches — primary headaches in particular. This is because the radiation from the smartphone can cause disturbances in the cortical stimulation and brain stem, causing changes in blood circulation in the brain and activate the brain stem. Furthermore, pain receptors will respond thus explaining the primary headache in smartphone users [9]. The objective of this study was to analyze the factors associated with the occurrence of Headaches in Smartphone Users. This study hypothesizes that there is a relationship between the duration, intensity of smartphone use and smartphone radiation levels and the incidence of headaches in smartphone users.

II. METHOD

The design of this study was descriptive-analytic with a cross-sectional approach. The respondents of this study were undergraduate students at the Faculty of Nursing, Airlangga University. The sampling technique used was probability sampling and the type of sample was simple random sampling. The sample consisted of 176 respondents and the inclusion criteria were: (1) Active smartphone users, (2) Never experienced a head injury or other neurological diseases. 176 selected respondents were contacted via electronic message (Whatsapp Messenger and Line). The research used the Google form system in the process of filling out the questionnaire.

The dependent variable of this study was the incidence of headaches. The independent variables of this study were the duration of smartphone use, the frequency of smartphone use, and the radiation level of the smartphone used. The radiation level refers to the SAR (*Specific Absorption Rate*) value of the smartphone being used. SAR values indicate high radiation (SAR value > 0.6 W / Kg) and low radiation (SAR < 0.6 W / Kg)[10].

The instrument of this study was a questionnaire consisting of the duration of smartphone use, the frequency of smartphone use, and the type of smartphone used with a validity test value between 0.526 - 0.603 and reliability value of 0.625. The headache questionnaire was adopted from Yasmin [11] and modified according to the International Classification of Headache Disorder. This questionnaire has been tested for validity and reliability with the results of the validity test between 0.390 - 0.808 and the reliability value 0.750. This study used the Spearman's rho test which assesses the relationship between the independent variable and the dependent variable, with a significance level of $p < 0.05$. This study protocol was approved by the Ethical Commission of the Faculty of Nursing Universitas Airlangga; the certificate number is 1478-KEPK

III. RESULT

Table1. Characteristic distribution of headache experience

Characteristics of Headache Experience	Category	Frequency	Percentage (%)
Headache	ever	140	79.5
	never	36	20.5
Total		176	100
Duration of the Headache	<30 minutes	88	62.9
	30 minutes - 7 days	38	27.1
	More than 7 days	0	0
	continuously (repeatedly)	14	10

Total		140	100
Frequency of Headaches in a Month	Ten episodes with average <1 day / month (infrequent)	120	85.7
	Ten episodes inside 1-15 days/month for a minimum of 3 month (frequent)	20	14.3
	> 15 days / month for > 3 months (chronic)	0	0
	Total	140	100
Location of the Headache	Bilateral	47	33.6
	Unilateral	93	66.4
Total		140	100
Accompanying Symptoms (phonophobia / photophobia)	Ever	42	30
	Never	98	70
Total		140	100
The intensity of the pain felt	Mild	114	82
	Moderate	24	17.3
	Severe	1	0.7
Total		139	100
The use of pain medication	Yes	71	50.7
	No	69	49.3
Total		140	100

Table 1 shows the experience of headaches for the respondents in this study. Almost all students (79.5%) experienced headaches in the last 3 months. The duration of the headache varies, but most (62.9%) felt it for less than 30 minutes. As many as 85.7% of students feel infrequent headaches, which is rare. If the total headache is less than 24 hours a month. Most students (52.1%) felt headaches on one side of the head only (unilateral).

Most students (70%) admit to headaches that occur without concomitant symptoms, either photophobia (abnormal intolerance to light) or phonophobia (abnormal intolerance to sound). Almost all students (82%) felt mild headaches numeric pain rating scale (NPRS) was in the range of 1-4 out of a total of 10, and only one person experienced severe headaches ranging between 8-10 in intensity.

Half of the students (50.7%) used painkillers to relieve headaches. The pain medications used are analgesics such as paracetamol, ibuprofen, mefenamic acid, as well as several trademark drugs that can be bought freely both in pharmacies and in supermarkets.

Table 2. Relationship between the duration of smartphone usage and headaches

Duration of Smartphone Usage	Headache				Total		p-value	r
	Yes		No		Σ	%		
	n	%	n	%				
Low	4	2.3	11	6.2	15	8.5	0.000	0.403
High	136	77.3	25	14.2	161	91.5		
Total	140	79.6	36	20.4	176	100		

Based on Table 2, almost all respondents use smartphones with a high duration of more than 6 hours a day. A total of 136 students (77.3%) experienced headaches and only 25 students (14.2%) with the use of high-duration smartphones did not claim to have any headaches.

The results of the Spearman Rho test carried out showed a p-value of 0,000 which means the duration of smartphone use is related to the incidence of headaches. The correlation level is sufficient ($r = 0.403$). Besides, the results of the positive correlation coefficient, which means that if the duration of smartphone use is getting higher, then the risk of headache will also increase.

Table 3. The relationship between the frequency of smartphone use and headaches

Frequency of Smartphone Use	Headache				Total		p-value	r
	Yes		No		Σ	%		
	n	%	n	%				
Low	42	23.9	23	13	65	36.9	0.004	0.217
High	98	55.7	13	7.4	111	63.1		
Total	140	79.6	36	20.4	176	100		

Based on Table 3, the majority of respondents (55.7%) use a smartphone with a high frequency of more than 35 times a day and only 7.4% of those do not experience headaches. This means that more respondents experience headaches with the high use of a smartphone.

Spearman rho test results showed a p-value of 0.004 which means that the frequency of smartphone use is associated with the incidence of headaches, with a weak correlation level ($r = 0.217$). The results of the positive correlation coefficient show that the two variables are in the same direction with the same high value. So, if the frequency of using a smartphone is getting higher, it will also increase the risk of headaches.

Table 4. The relationship between smartphone radiation levels and headaches

Smartphone Radiation Level	Yes		Headache No		Σ	Total %	p-value	r
	n	%	n	%				
Low	52	29.6	18	10.2	70	39.8	0.978	0.002
High	88	50	18	10.2	106	60.2		
Total	140	79.6	36	20.4	176	100		

Based on Table 4 the majority of respondents (60.2%) use smartphones with high radiation levels ie the SAR value of the smartphones used is above 0.6 W / Kg, and 50% of them experience headaches. Only a few people (10.2%) who use smartphones with high radiation did not experience headaches. The results of the Spearman Rho performed showed a p-value of 0.978 which means that the level of smartphone radiation is not related to the incidence of pain.

IV. DISCUSSION

- The relationship between the Duration of Smartphone Usage and Headache Incidence

The results of this study indicate that using the smartphone for over 6 hours a day can increase the risk of headaches in smartphone users. Although there are students who use smartphones for more than 6 hours a day and do not experience headaches, the proportion is not comparable to those who do experience headaches.

The high use of smartphones in this study is supported by a survey conducted by Brown in 2014 stating that Indonesia ranks first in smartphone usage where the average usage is 9 hours per day [12]. Besides, other research states that students using smartphones for more than one hour per day can experience several health problems, such as headaches, earaches, blurred vision, and insomnia [13].

When someone uses a smartphone to surf the internet, chat, or send e-mails, this will cause disturbances in the form of eye fatigue, sleep disorders, and headaches. This phenomenon is called technostress or stress because technology can affect a person both physically and mentally [13].

Headache complaints were found to be significantly higher in high smartphone users (use with a total duration of more than 4 hours a day) than in those who were not. The duration and frequency of headache attacks are also higher in those who are high smartphone users [14]. Other studies illustrate risk factors for smartphone users for students who use smartphones between 6-7 hours a day. Headaches that occur to smartphone users are often associated with the eye, can be due to eye disorders, eye strain and eye fatigue due to excessive viewing of the smartphone screen [2].

Headache is more common in those who are smartphone users than those who are not. Besides, the incidence of headache also increases if they use the old call feature on their cellphone [15]. The occurrence of headaches in smartphone users can be caused by the electromagnetic fields generated by smartphone radiation which can lead to the movement of currents in fluids in the human body. These currents can cause stimulation of the nervous system and human muscles which in turn cause biological effects. This radiation can cause human body cells to absorb energy in parts of the body's fluids, changes in cell functional activity, and can subsequently induce headache events [16].

The occurrence of headaches can be also due to damage to the blood-brain barrier (BBB). BBB is a bridge between the blood vessels and the human brain. BBB will filter pathogens and poisons that enter the brain tissue [16]. However,

exposure to electromagnetic fields caused by smartphones was proven to affect BBB and cause cognitive damage in mice in the experiment. In the study, mice were exposed for 14 and 28 days. The mice in the 28-day group had greater cognitive damage and experienced cellular edema. Researchers state that these results are due to exposure to 900 MHz electromagnetic field radiation causing damage to the permeability of the BBB. This BBB permeability damage will cause pathogens and toxins to enter the brain freely. So the brain is more at risk for inflammation[17].

Research done shows that the incidence of headache occurs in students who use smartphones with a high duration, which is more than 6 hours. This can mean that the longer a person uses a smartphone in a day, the higher the incidence of headaches. Headaches can have a major effect on performance and productivity on smartphone users. The adverse effects of smartphone use on health must be monitored regularly on students to prevent the adverse effects of smartphone use, or prevent the occurrence of headaches in particular.

- The relationship between Frequency of Smartphone Usage and Headaches

The results of this study indicate that the frequency of smartphone usage above 35 times a day can increase the risk of headaches in smartphone users in the Faculty of Nursing, Airlangga University. Although there are students who use smartphones with a frequency of more than 35 times a day and do not experience headaches, the proportion is not comparable to those who do experience headaches.

High and frequent smartphone usage is a very common problem in society. Most smartphone users aged 21-25 claimed to use smartphones quite often, more than 30 times per day[15].

Other studies have shown that one hundred percent of students in the Faculty of Medicine of Oman use smartphones during and after class and this causes several health problems, with headaches being just one example [16].

The incidence of headaches was also reported by 227 students from a total sample of 459 students in the study conducted by[16]. Although several other factors can trigger headaches, frequent headache attacks have been reported due to excessive and frequent use of smartphones. Radiation from a smartphone is believed to affect the part of the head closest to the smartphone when it is used. Other studies have shown that the majority of the population (57%) check their smartphones every 30 minutes. And nearly 45% of them complained of several health-related problems such as headaches and others [13].

The incidence of headaches in smartphone users with a high frequency of use can be caused by blue-light or blue-ray eyes produced by smartphones. Blue rays generally have wavelengths between 380 nm - 500 nm. The human retina is protected from short, destructive radiation waves, and the cornea will only absorb the light below 295 nm and the eye crystal cells will only absorb below 400 nm. However, the shorter the waves, the greater the resulting energy. The blue light produced by a smartphone can reach the retina and cause oxidative stress in the outermost segment of the photoreceptors[18].

Blue rays on smartphones are classified as causing headaches in smartphone users. This is in line with research conducted on 43 patients with migraines who did not have a headache; the process was then recorded through electroretinography and they were exposed to white light, then blue, green, yellow, and red. The results, respondents of the study will feel a migraine which is then called photophobia migraine. The study states that light can cause headaches when it rotates around the trigeminal nerve which is the largest nerve in the brain which controls sensory information as well as facial and head motion functions. The beam transmits through the retina and then involves nerve fibers in one branch of the trigeminal system. This process then causes blood vessels to dilate and migraine photophobia occurs[18].

In this study, most students use smartphones more than 35 times per day, and as many as 56.3% of them experience headaches. This shows that the more often a person uses a smartphone, the greater the risk of headache attacks. This happens because the human eye adjusts many times to the blue light produced by smartphones. The incidence of headaches can also be triggered by other things, but when it comes to using a smartphone, it is necessary to reduce the frequency of use of the smartphone so these types of headaches do not occur.

- The relationship between Smartphone Radiation Level and Headache Occurrence

The results of this study indicate that the smartphone radiation level based on the smartphone used has no influence on the incidence of headaches in smartphone user students at the Faculty of Nursing at Airlangga University. Although the respondents experienced headaches when using a smartphone with high radiation, the results of the statistical tests conducted showed no relationship.

Electrohypersensitivity is a syndrome that is a combination of excessive fatigue, headache, memory disorders, dizziness, irritability, sleep disorders, loss of appetite, and other feelings of pain caused by exposure to electromagnetic waves. Electrohypersensitivity events can be caused by excessive use of smartphones, especially their use near the head [15].

Radiation from electromagnetic waves generated by smartphones cannot be seen or felt, so users will not feel the danger due to excessive use until they feel a change or a real health disturbance [15]. Smartphones work by giving signals and capturing signals from cellular network towers using electromagnetic waves. At high levels, electromagnetic waves can heat tissue in the human body. When a smartphone is used near the head, this will cause a person to be exposed to energy from electromagnetic waves greater than usual. The body tissue closest to the smartphone will absorb more energy than other tissues whose range is further away [19].

When the human body is exposed to electromagnetic radiation, the body absorbs radiation, because 70% of the human body is fluid. Especially in the brain that contains 90% of the fluid. Besides, radiation exposure from an old smartphone will damage the BBB or the blood-brain barrier. This will harm the brain because the barrier guarding it is damaged [15]. The adverse effects of exposure to electromagnetic waves on health depend on the strength of the radiation and the frequency of exposure. The amount of radiation power transmitted by the towers differs from one smartphone to another, depending on what is blocking the radiation transmission, such as buildings and trees. The amount of radiation produced by the smartphone itself depends on the number of towers in the surrounding area, the density of the cellular network used, and the distance from the smartphone to the closest tower [15].

Smartphones make it easy and help one's everyday life. The use of smartphones is inevitable so someone can be very dependent on technology. The benefits are various but smartphone radiation can cause numerous health problems. Radiation generated from smartphone usage depends on the number of towers around, the density of cellular network traffic used, and the amount of energy received by the smartphone from the network tower and the distance of the smartphone from the nearest tower. The more energy received, the more energy emitted. The use of smartphones by actively using networks and signals will emit more radiation. So the more actively someone uses a smartphone, the higher the radiation produced by the smartphone. Conversely, for a smartphone that is not used actively, the radiation emitted will be minimal. Therefore, user policies are needed to reduce the risk of hazards that can threaten health.

We found no limitations for this study.

V. CONCLUSION

The conclusion of this study was the duration of smartphone use and the frequency of smartphone use are positively and strongly related to the incidence of headaches in smartphone user students. However, the radiation level of the smartphone used is not related to the incidence of headaches. Everyone is advised to use smartphones wisely and not too much. When using a smartphone everyone must pay attention to the SAR level. Researchers can then do more in-depth research related to smartphone radiation levels, stress on the incidence of headaches, and health promotion about wise smartphone usage.

CONFLICT OF INTEREST

No conflicts of interest have been declared.

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