The Potential Eye Health Risks Associated with Smartphone Radiation Exposure Among Elementary School-Aged Children in Urban and Rural Areas in Jember-Indonesia

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Abstract. Smartphones have been used widespread, and elementary school-age children are no exception. In using smartphones, they behave riskily causing eye health problems due to the emitted radiation. Children's behavior in using smartphones is estimated to be different between those in rural and urban areas. This study aimed to identify the differences in the potential eye health risks of smartphone use among elementary school-aged children in urban and rural areas. This Analytic Observational Research with Cross-sectional design involved 60 families in Jember Indonesia from an urban elementary school (Muhammadiyah 1 Jember Elementary School) and a rural elementary school (Bintoro 2 Public Elementary School), each with 30 respondents. Inclusion criteria: possessing smartphones, healthy and willing to be a respondent. The variable studied was the potential risk of eye health in the use of smartphones among elementary school-aged children. Data were collected using questionnaires with 7 open-ended questions sent to respondents via the WhatsApp application. Each question was categorized and scored as a potential risk value. The data obtained were analyzed using non-paired T-Test (=0.05). In the group of elementary school children in urban areas, the value of potential health risk was 44.71 and for rural children was 48. There was no significant difference between the two groups ($p > 0.05$). There is no difference in the risk of eye health in smartphone use between urban and rural primary school-aged children.

Keywords: potential risk · eye health · smartphone · school-aged children · urban area · rural area

1 Introduction

Subsequent paragraphs, however, are indented. Cell phones or the-so called mobile phones are electronic telecommunication devices that have the same basic capabilities as conventional telephones. One of the advantages is that they can be carried everywhere. A smartphone is a portable device that combines mobile telephone and computing functions into one unit [1]. Currently, smart phones are equipped with various functions or features

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that make it easy since they are equipped with an internet connection and provide Personal Digital Assistant (PDA) functions such as calendars, agenda [2, 3] books, calculators, notes, and various advanced applications such as cameras, play games, play videos, navigation, e-mailing, and social networks (Facebook and Instagram) to help with daily activities [1, 4, 5].

Smartphones have now become the major communication tool for humans and have even become the human's main needs. The use of smartphones in society is not only limited to adults but is also widely used by children. A study states that half (52%) of children have been able to access various communication tools, and the highest is smartphones (41%), even around 6% of children aged 2–5 years have their own smartphone [6, 7]. Data from the Ministry of Communication and Information of the Republic of Indonesia in 2018 show that 93.52% of social media are used by Indonesian individuals aged 9–19 years, and the internet use by individuals is 65.34% [4, 8]. The high use of smartphones in children is estimated to deal with entertainment applications that are very popular among children, such as video games.

The use of smartphones among children today is increasingly worrying due to the improper and excessive use, so that it has negative impacts on their health. Previous studies found that there were different behaviors in smartphone usage between elementary school children in urban and rural areas in Jember Indonesia [9, 10]. Using a smartphone in an improper way will experience many problems, including eye health problems ranging from mild to severe, such as reduced eye acuity, blurred vision, dry eyes, sore eyes [4, 6, 9], red eyes, watery, sore, itchy/dry, drowsy, tense, blurred vision, double vision, headache, and difficulty concentrating (Computer Vision Syndrome (CVS). Worldwide, an estimated 19 million children have eye health problems or visual impairment. Visual impairment can have profound effects on children's development, quality of life, educational attainment, and economic productivity [11].

This study aims to identify and explain the differences in potential eye health risks in smartphone use among primary school-aged children in urban and rural areas.

2 Methods

This analytic observational study used a cross-sectional design. The research population was families with elementary school-aged children. This study involved 60 respondents (families) from students of Muhammadiyah 1 Jember Elementary School (representing urban area) and Bintoro 2 Public Elementary School (representing rural area) with the inclusion criteria: having an Android cellphone in their family, healthy and willing to be respondents. Respondents were determined by non-probability purposive sampling. The variables studied were the potential risks of eye health in using smartphones among elementary school-aged children.

The research was conducted in 2020 in Jember, East Java, Indonesia. The respondents were parents of students from both elementary schools. Due to the Covid- 19 pandemic, this research was conducted using a survey method using the WhatsApp application. The research instrument was an open questionnaire containing 7 questions related to the variables studied. Data collection was preceded by informed consent by making telephone contact with the respondent. The value of the potential risk of visual impairment

Table 1. Distribution of Respondent (n = 60)

Variable		Urban		Rural	
		f	%	f	%
Age	<6	1	3.3	0	0
	6–8	7	23.3	9	30
	8–10	9	30	10	33.3
Gender	>10	13	43.3	11	36.7
	Male	17	56.7	20	66.7
Parents' educational background	Female	13	43.3	10	33.3
	Elementary School/Out of School	1	3.3	5	16.7
	Junior High School	1	3.3	17	56.7
	Senior High School	4	13.3	6	20
	Bachelor	24	80	2	6.6
Parents occupation	Unemployed	0	0	5	16.7
	Farmer	2	6.6	15	50
	Government Employee	18	60	2	6.6
	Private Employee	10	33.3	8	26.7

was calculated by multiplying the category score of each answer to the question by the number of respondents. The data obtained were then analyzed using a non-paired T-test with = 0.05.

3 Result

From Table 1, the respondent children's age and gender are evenly distributed, but most of them are older than 8 years old. Parents' education for urban elementary school respondents is mostly undergraduate education (80%) while rural elementary school respondents are mostly junior high school (56.7%). Parents' occupations in urban elementary school respondents are mostly government employees (60%) and in rural are mostly farmers and private sector employees (50% and 26.7%).

4 Discussion

Smartphone is a communication tool that is growing rapidly and widely used; not only for communication but also for various other purposes, not only in urban areas but also in rural areas, used not only by adults but also by children. The use of smartphones in children includes communication with parents, for learning especially in online learning during the covid-19 pandemic, and most of them use smartphones for gaming [2, 5, 8, 12].

Besides the many positive properties of smartphones, they have certain negative aspects, such as eye health problems or visual impairments. Previous studies found differences in the behavior of using smartphones among children between urban and rural areas [1, 4, 5, 9]. This study further intends to analyze how the potential health risks, especially eye health, in smartphone use among children in urban and rural areas. The results showed that there was no difference in potential eye health risks in smartphone use between urban and rural children [11, 13–16]. Some Children's behaviors in using smartphones have a risk of health problems including eye health. symptoms include reduced eye acuity, blurred or double vision, dry eyes, tiredness, and sore eyes. The potential for eye health problems is caused by radiation emission, namely electromagnetic radiation in the form of microwave radiation that can hit the User's eyes. The wavelength of radiation emitted by smartphones ranges from 900–1900 MHz. This radiation is higher than that produced by SUTET (Extra High Voltage Airline) which only causes radiation of 50 Hz 10. The leading cause of visual impairment in children is uncorrected refractive error; and this visual impairment can be corrected by wearing glasses [16–19].

Anatomically and physiologically, the human eye is designed to see distant objects for a long time and see near objects in a short time. When the eyes are made to stare at a computer or mobile phone screen at close range and for a long time, it means that we have used our eyes inappropriately. Thus, the ciliary muscle will affect the lens so that it becomes convex because it always sees close objects. As a result, the eyes will be depressed and become less sensitive to distant objects and cause visual acuity disorders [11]. Another study found that the screen time factor (duration of exposure) with the monitor screen when playing video games more than 2 h per day had a significant relationship with visual acuity [14, 15, 20, 21].

Radiation is generally divided into ionizing and non-ionizing radiation; both are distinguished by their wavelength. Radiation with a wavelength of more than 100 A (Angstrom) is included in non-ionizing radiation [2, 3, 12]. The radiation emitted by smartphones is non-ionizing electromagnetic radiation. Non-ionizing radiation differs from ionizing radiation such as gamma rays, X-rays, and ultraviolet light [13, 14], which exhibit high-frequency waves and have enough energy to liberate an electron from molecules. Although non-ionizing radiation has a lower frequency and is generally considered safe, accumulating evidence suggests that some types of non-ionizing electromagnetic radiation have enough energy to harm living tissues [1, 2, 5, 8].

Several variables of smartphone use that are estimated to be at risk for eye health are: smartphone possession, duration of using a cellphone in one use, duration of use of a smartphone in a day, body position in using a smartphone, position/alignment of the smartphone to the body, and the distance of the smartphone to the eyes/head. Based on these variables, our study obtained the value of potential eye health risks that are descriptively different between elementary school-aged children in urban and rural areas but statistically not significantly different. These behavioral differences can be associated with the socio-cultural and economic factors of the community [13–16, 22]. The education factor is one of the causes because behavior is strongly influenced by education or knowledge factors, in this case the education of their parents and the surrounding community. This is in accordance with the concept or theory that knowledge or education is the first domain that is very important in shaping behavior [3, 5, 8]. The socio-cultural

and economic factors of urban communities are related to several problems, including parents who do not have time to pay attention to their family/children. However, in general, they have advantages where their education, insight, work and economy are better [11, 14, 16, 18]. This is certainly different from the people of the suburbs, where their educational background, insight and economic level is lower. This is supported by general data from respondents in this study (Table 1).

5 Conclusion

There is no difference in potential eye health risks on smartphone use in elementary school-aged children between urban and rural elementary school children.

References

1. S. M. J. Mortazavi, S. A. R. Mortazavi, and M. Paknahad, "Association between Exposure to Smartphones and Ocular Health in Adolescents.," *Ophthalmic epidemiology*, vol. 23, no. 6. England, p. 418, Dec. 2016. doi: https://doi.org/10.1080/09286586.2016.1212992.
2. J. Kim, Y. Hwang, H. G. Yu, and S. K. Park, "Reply to the Letter to the Editor, 'Association between Exposure to Smartphones and Ocular Health in Adolescents'.," *Ophthalmic epidemiology*, vol. 23, no. 6. England, p. 419, Dec. 2016. doi: https://doi.org/10.1080/09286586.2016.1212993.
3. J. Kim *et al.*, "Association between Exposure to Smartphones and Ocular Health in Adolescents.," *Ophthalmic Epidemiol.*, vol. 23, no. 4, pp. 269–276, Aug. 2016, doi: https://doi.org/10.3109/09286586.2015.1136652.
4. A. M. Mallya and E. W. N. Lam, *White and Pharoah's oral radiology*. Elsevier St. Louis (MO), 2019.
5. Y.-J. Choi and Y.-S. Choi, "Effects of electromagnetic radiation from smartphones on learning ability and hippocampal progenitor cell proliferation in mice," *Osong public Heal. Res. Perspect.*, vol. 7, no. 1, pp. 12–17, 2016.
6. F. Rudhiati, D. Apriany, and N. Hardianti, "Hubungan durasi bermain video game dengan ketajaman penglihatan anak usia sekolah," *J. Sk. Keperawatan*, vol. 1, no. 2, pp. 12–17, 2015.
7. H. K. Rono *et al.*, "Smartphone-based screening for visual impairment in Kenyan school children: a cluster randomised controlled trial," *Lancet Glob. Heal.*, vol. 6, no. 8, pp. e924–e932, 2018.
8. S. Mallya and E. Lam, *White and Pharoah's Oral radiology E-book: principles and interpretation: second South Asia Edition E-Book*. Elsevier India, 2019.
9. I. Karsini and S. Revianti, "Pengaruh Paparan Radiasi Telepon Genggam Terhadap Aktivitas Enzim Katalase Kelenjar Parotis Rattus norvegicus Strain Wistar," *DENTA*, vol. 10, no. 2, pp. 149–158, 2016.
10. S. Nuryani, M. Ali, and D. Yuniarni, "Peningkatan Kemampuan Motorik Halus melalui Kegiatan Kolase dengan Menggunakan Bahan Alam," *J. Pendidik. dan Pembelajaran Khatulistiwa*, vol. 2, no. 9.
11. A. Nath and S. Mukherjee, "Impact of Mobile Phone/Smartphone: A pilot study on positive and negative effects," *Int. J.*, vol. 3, no. 5, pp. 294–302, 2015.
12. C. Le Menn-Tripi, A. Vachaud, N. Defas, J. Malvy, S. Roux, and F. Bonnet-Brilhault, "[Sensory-psychomotor evaluation in Autism: A new tool for functional diagnosis].," *Encephale.*, vol. 45, no. 4, pp. 312–319, Sep. 2019, doi: https://doi.org/10.1016/j.encep.2018.12.003.

13. M. Kashiwagi and S. Suzuki, "[Simple and useful evaluation of motor difficulty in childhood (9–12 years old children) by interview score on motor skills and soft neurological signs--aim for the diagnosis of developmental coordination disorder].," *No to hattatsu = Brain Dev.*, vol. 41, no. 5, pp. 343–348, Sep. 2009.
14. E. Chaplais, G. Naughton, D. Thivel, D. Courteix, and D. Greene, "Smartphone Interventions for Weight Treatment and Behavioral Change in Pediatric Obesity: A Systematic Review.," *Telemed. J. e-health Off. J. Am. Telemed. Assoc.*, vol. 21, no. 10, pp. 822–830, Oct. 2015, doi: https://doi.org/10.1089/tmj.2014.0197.
15. R. Plackett, S. Thomas, and S. Thomas, "Professionals' views on the use of smartphone technology to support children and adolescents with memory impairment due to acquired brain injury.," *Disabil. Rehabil. Assist. Technol.*, vol. 12, no. 3, pp. 236–243, Apr. 2017, doi: https://doi.org/10.3109/17483107.2015.1127436.
16. X. Cao *et al.*, "Risk of Accidents or Chronic Disorders From Improper Use of Mobile Phones: A Systematic Review and Meta-analysis.," *J. Med. Internet Res.*, vol. 24, no. 1, p. e21313, Jan. 2022, doi: https://doi.org/10.2196/21313.
17. Z. Genc, "Parents' perceptions about the mobile technology use of preschool aged children," *Procedia-Social Behav. Sci.*, vol. 146, pp. 55–60, 2014.
18. I. G. Kucuk, U. Eser, M. Cevik, and K. Ongel, "Mobile phone usage characteristics of children at school and parents' approach," *Medicine (Baltimore).*, vol. 9, no. 2, pp. 503–508, 2020.
19. S. W. Asih and G. S. Adi, "Behavior Characterization of Use of Mobile Phones which Potentially Cause Health Problems of Elementary School-Age Children in Rural and Urban Areas," *J. Kesehat. dr. Soebandi*, vol. 9, no. 1, pp. 31–37, 2021.
20. L. M. da C. Andrade, M. M. F. P. da S. Martins, C. S. Fernandes, and H. I. V. M. Fernandes, "Validation of the content of a children's game to promote the nursing profession.," *Rev. Gauch. Enferm.*, vol. 42, p. e20200435, 2021, doi: https://doi.org/10.1590/1983-1447.2021.20200435.
21. K. E. Miller, "ORIGAMI MODEL FOR TEACHING BINOCULAR INDIRECT OPHTHALMOSCOPY.," *Retina*, vol. 35, no. 8, pp. 1711–1712, Aug. 2015, doi: https://doi.org/10.1097/IAE.0000000000000710.
22. R. Mejía-Arauz, B. Rogoff, A. Dexter, and B. Najafi, "Cultural variation in children's social organization.," *Child Dev.*, vol. 78, no. 3, pp. 1001–1014, 2007, doi: https://doi.org/10.1111/j.1467-8624.2007.01046.x.