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Family History and Smartphone Use Associated with Refractive Error in School-Aged Children

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Abstract

The prevalence of Refractive Error (RE) in school children tends to increase. The study aims to analyze the prevalence and determinants of RE in elementary school children. The research was carried out in 2022, using a cross-sectional design. The research population is 110 students in grades V and VI of Krapyak State Elementary School, Semarang City. A total of 80 students were selected as samples with purposive sampling techniques. Data collection was carried out by interview techniques using questionnaires. RE is measured by Snellen Chart examination and pinhole lens. The multiple logistic regression multivariate test was used for risk factor analysis. The bivariate analysis resulted in 6 variables eligible for inclusion in the multivariate analysis model. The results of the multivariate analysis showed that there were 2 risk factors for RE, namely: smartphone use ≥ 2 hours continuously per day (OR = 14.622 95% CI 1.124 - 190.181) and parental history (OR = 11.194, 95% CI 1.827 -65.567). The probability of RE if a student has both risk factors is 71%. The use of smartphones ≥ 2 hours continuously per day and the presence of parental history of RE are risk factors for RE events in elementary school students.

Introduction

Refractive error (RE) is an eye health problem with an increasing prevalence (Sharma et al., 2012). RE can occur in all age groups, including school children. Research shows that most RE begins to occur in childhood. Some studies show that the prevalence of myopia increases in children aged 6-12 years (Lindquist, Cama and Keeffe, 2011; Gao et al., 2012; Alem and Gebru, 2021). RE contributes as one of the causes of vision loss. Uncorrected RE is the main cause of Low Vision in the world (Hashemi et al., 2018; Sharma et al., 2020). In Indonesia, the prevalence of RE ranks first in eye diseases. From year to year, RE shows an increasing trend. It is estimated that a quarter of Indonesia's population experiences RE. RE is the first rank in the top ten eye diseases in Indonesia (Ministry of Health, 2019).

A preliminary study conducted on grade V students of Krapyak State Elementary School, Semarang City, showed that 25% of students experienced RE. RE in children is a problem that must be addressed immediately. Visual impairment in school children can affect student learning achievement. In general, 80% of information during the first 12 years of a child's life is obtained through vision. In addition, 30% of information will be absorbed through vision. Because the delay in making refractive corrections, especially in school-age children, will greatly affect the ability to absorb learning materials. This will lead to a reduced potential for increased intelligence (Sharma et al., 2012; Al Wadaani et al., 2013; Khouj et al., 2023). Children with RE often do not complain

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of visual impairment. The child only shows symptoms that indicate visual impairment through daily behavior (Al-Bahhawi et al., 2018; Santiago et al., 2023). Therefore, a study is needed to determine the magnitude of the RE problem and its determinants. The purpose of the study was to analyze the prevalence and risk factors of RE in elementary school children.

Method

This study is an observational study with a cross-sectional design. The research was carried out in March – July 2022. The research population is 110 students of Class V and VI of Krapyak State Elementary School Semarang. The minimum number of samples is calculated by the following formula:

$$n = \frac{Z^2_{1-\alpha/2}\, p\,(1-p)\, N}{d2\,(N-1) + Z^2_{1-\alpha/2}\, p\,(1-p)}$$

n = number of samples; N = total population; d = Error rate (5%); Z21-α/2 = Z value based on 95% confidence (1.96); p = proportion of refractive error (25%).

Based on the calculation of the minimum number of samples, a total of 80 students were obtained. The sample was selected by purposive sampling technique. The inclusion criteria for the sample were: 1) the child was willing to participate in research activities; 2) children present at school during the implementation of research. The sample exclusion criteria are: 1) children with eye diseases other than refractive errors; 2) the child is uncooperative in the examination; and 3) children who use visual aids and whose vision is normal.

The study-bound variable was RE. The independent variables are: 1) length of reading/writing activities per day, 2) distance between eyes and reading/writing objects, 3) distance from watching television, 4) length of continuous smartphone use every day, 5) mother's work, 6) mother's education, 7) parent's RE history, 8) age; 9) gender, 10) nutritional status.

Data collection was carried out by interviews using instruments in the form of questionnaires. RE is measured by Snellen Chart examination and pinhole lens. The data were analyzed univariately, bivariate, and multivariate using multiple logistic regression. The research has received ethical feasibility from the UNNES Health Research Ethics Committee with letter number 041/KEPK/EC/2022.

Results and Discussion

Most of the research subjects were females. The characteristics of the age of the research subjects are in the range of 10 to 12 years. The distribution and frequency of research subjects by gender and age are shown in table 1:

The results showed that the prevalence of RE was 22.5%. Until now, there is no data from a national survey on the prevalence of RE in elementary school children. However, the prevalence of 22.5% found in this study is almost the same as several other studies that teach RE to elementary school children (Rezvan et al., 2012; Paudel et al., 2014; Okafor et al., 2021). The analysis of RE risk factors can be seen from the results of the bivariate analysis

Table 1. Characteristics of Research Subjects.

Characteristic		Frequency (n)	Percent (%)
Gender	Woman	47	58.8
	Man	33	41.3
	Total	80	100.0
Age	10 years	33	41.3
	11 years	33	41.3
	12 years	14	17.5
	Total	80	100.0

Source: Primary data of research, 2022.

Table 2. Results of Bivariate Analysis of RE Risk Factors.

Independent Variable	Exist	Refractive Disorders			P-value	RP, 95% CI
		Not	Total			
Length of reading/writing activities	≥2 hours	16 (53.3)	14 (46.7)	30 (100.0)	0.0001	3.333 (3.293 – 53.991)
	< 2 hours	2 (4.0)	48 (96.0)	50 (100.0)		
Eye distance to read/write objects	≥30 cm	13 (44.8)	16 (55.2)	29 (100.0)	0.0001	4.572 (1.813 – 11.533)
	> 30 cm	5 (9.8)	46 (90.2)	51 (100.0)		
Distance watching television	< 7x the width of the TV	14 (60.9)	9 (39.1)	23 (100.0)	0.0001	8.674 (3.190 – 23.582)
	≥ 7x the width of the TV	4 (7.0)	53 (93.0)	57 (100.0)		
Smartphone usage time	≥ 2 hours per day	17 (58.6)	12 (41.4)	29 (100.0)	0.0001	29.897 (4.192 – 213.223)
	< 2 hours per day	1 (2.0)	50 (98.0)	51 (100.0)		
Mother's work	work	4 (30.8)	9 (69.2)	13 (100.0)	0.475	1.473 (0.576 – 3.766)
	not working	14 (20.9)	53 (79.1)	67 (100.0)		
Mother's education	Not graduating from junior high school	5 (31.3)	11 (68.8)	16 (100.0)	0.338	1.538 (0.642 – 3.686)
	More than a junior high school graduate	13 (20.3)	51 (79.7)	64 (100.0)		
Parent's RE history	There is a history	14 (56.0)	11 (44.0)	25 (100.0)	0.0001	7.70 (2.817 – 21.049)
	No history	4 (7.3)	51 (92.7)	55 (100.0)		
Age	9–12 years	18 (22.5)	62 (77.5)	80 (100.0)	-	-
	6–8 years	0	0	0		
Gender	Woman	15 (31.9)	32 (68.1)	47 (100.0)	0.016	3.511 (1.104 – 11.164)
	Man	3 (9.1)	30 (90.9)	33 (100.0)		
Nutritional status	Malnutrition	4 (36.4)	7 (63.6)	11 (100.0)	0.256	1.792 (0.721 – 4.457)
	Usual	14 (20.3)	55 (79.7)	69 (100.0)		

Source: Primary data of research, 2022

as shown in the following Table 2:

Table 2 shows that 3 independent variables were not shown to be associated with RE events. The three independent variables are maternal employment, maternal education, and nutritional status of students. One variable cannot be analyzed because of the same variability, namely the age variable. This can be seen from the age distribution of students who have the same age category range. The results of the bivariate analysis in Table 2 show that 6 independent variables are significantly proven as risk factors for RE, namely: 1) the duration of reading activities; 2) the distance between the eyes and the reading object; 3) TV viewing distance; 4) The length of continuous smartphone use every day; 5) Family history with RE; 6) Gender. Based on the results of the bivariate analysis, a multivariate analysis was then carried out. The independent variable of the study that had a p-value of < 0.25 was included in the multivariate modeling. Table

Table 3. Results of Multivariate Analysis

Variable	*P-value*	Exp (B)	95% CI	
			Lower limit	Upper limit
Length of reading or writing activities per day	0.220	11.297	0.234	545.319
Eye distance to read/write objects	0.621	0.507	0.034	7.488
Distance watching television	0.879	1.227	0.087	17.308
The length of continuous use of smartphones every day	0.040	14.622	1.124	190.181
Family RE history	0.009	11.194	1.827	68.567
Gender	0.300	3.040	0.372	24.872

Source: Primary data of research, 2022.

2 shows that 6 variables have a value of p< 0.25. The results of the multivariate analysis of multiple logistic regression can be seen in the following table 3:

The results of the feasibility test on the multivariate model in Table 3 show the significance of the Hosmer and Lemeshow test of 0.567. This means that multivariate models have feasibility. Table 3 shows that of the 6 independent variables included in the model, 2 variables are significantly related to the incidence of RE in elementary school students. The two variables are: 1) Parent's history of RE, and 2) Duration of smartphone use per day.

Table 2 shows that the parental history variable has a p-value < 0.05 with OR = 11.194, 95% CI 1.827 -65.567. The long variable of continuous smartphone use also has a p < value of 0.05 with OR =14.622 95% CI 1.124 - 190.181. The OR value with a confidence interval of more than 1 indicates that this variable is a risk factor for RE in elementary school children. Meanwhile, the results of the Negelkerke R square analysis from the multivariate model showed a value of 0.713. The multivariate analysis model in this study shows that the history of RE in the family and the length of smartphone use are risk factors for RE in elementary school students. The results of the multivariate analysis showed that students who had a family history of ER had an almost 11 times greater risk of developing ER than students who did not have a parental history of RE. Students who have the habit of playing smartphones ≥ 2 hours continuously per day have almost 14 times greater risk of experiencing RE than students who play smartphones < 2 hours per day.

The results of the Negelkerke R square analysis of the multivariate model showed a value of 0.713. This means that if a student simultaneously has 2 risk factors for having a family history of RE and has the habit of playing smartphones ≥ 2 hours per day, then the student has a probability of experiencing RE of 71%. The results of the study showed that family history as a risk factor for RE was in line with previous research. Previous research has shown that children whose parents have a history of RE, the child is 2 times more likely to develop RE (Jones-Jordan et al., 2010; Lim et al., 2014). Another study found that the risk of ER in children with a parental history is 3 times greater to experience RE (Alem and Gebru, 2021; Worku et al., 2023).

Parental history as a risk factor for ER turns out to be more influential if both parents have a history. Research by Lim et al. (2014), in elementary school-age children in China found that the prevalence of RE is increasing with the presence of a parent's history of RE. In the study, it was found that the prevalence of RE in children without parental history was 49.77%. The prevalence of RE in children with a history of one parent is 59.62%. The prevalence in children with a history of both parents is 64.42% (Lim et al., 2014).

Family history as a risk factor for RE is a variable that cannot be modified (Ezhilvathani, Suruthi and Jeiganesh, 2019). Nevertheless, early detection of RE is indispensable. The introduction of RE risk factors is very necessary

as an effort to prevent RE problems early. Students who have a history of parents need to receive special education. The student must receive the attention of the school to be able to control other risk factors, especially related to behavioral factors of eye health (Okafor et al., 2021; Wang et al., 2022).

In addition to parental history, this study proves that smartphone use ≥ 2 hours continuously is a risk factor for RE events. Prospective observational studies on children and adolescents in Hong Kong also showed similar results. The study found that exposure to smartphones or tablets for more than 2 hours per day increased the risk of RE events (Red et al., 2020). Meanwhile, the research by Enthoven et al. (2021) shows that teenagers in the Netherlands use smartphones for about 4 hours per day. Continuous smartphone use for more than 20 minutes is associated with the incidence of RE, especially in adolescents who do not do much outdoor activity (Enthoven et al., 2021).

The duration and frequency of smartphone use in adolescents seem to be inversely proportional to the time spent doing physical activities outdoors. This is confirmed by Wang et al. (2019), in his research, it was proven that rural people who are used to doing physical activities outdoors have a lower risk of experiencing RE than urban people (Money et al., 2019). Continuous use of smartphones ≥ 2 hours per day can lead to conditions where the eyes are unable to maintain focus on objects at close range. This will cause shadows that enter the retina to be out of focus, causing biochemical changes in the structure of the sclera and choroids that play a role in regulating the axial elongation of the eyeball (Jaiswal et al., 2019; Angmalisang, Moningka and Rumampuk, 2021).

The use of smartphones in school children in the last 2 years has increased significantly. This is because the online learning method during the COVID-19 pandemic requires students to access learning through online media (Angmalisang, Moningka and Rumampuk, 2021; Rochmayani and Cahyaningsih, 2021). Currently, the use of smartphones or tablets is not only for the sake of learning, but students also use smartphones for play activities. This causes the length of exposure to the smartphone screen to be longer (Lanca and Saw, 2020; Foreman et al., 2021). Efforts to prevent RE in elementary school children can be carried out through surveillance and early detection (Sharma et al., 2020; Chu et al., 2023). Students who have experienced RE must get corrective action so that their condition does not worsen (Al-Bahhawi et al., 2018). Education to students, parents, and school residents is also very necessary. Education is expected to increase health literacy (Budiono et al., 2024), especially literacy about eye health. Good eye health literacy is needed to increase awareness of RE problems in elementary school children (Lanca and Saw, 2020; Chu et al., 2023).

Conclusion

Based on the results of the study, it can be concluded that the prevalence of RE in students of Krapyak State Elementary School, Semarang City is 22.5%. Variables that are significantly proven to be risk factors for RE are: 1) Duration of smartphone use; and 2) Parental history. The probability of RE if students simultaneously have a risk factor for prolonged smartphone use ≥ 2 hours per day and a history of parents is 71%. Based on the findings of research that show the high prevalence of refractive errors, it is recommended to carry out early detection of RE in students periodically. The results of early detection can be followed up by communication to the student's parents and public health service centers. Education related to exposure to smartphones that can cause eye health problems also needs to be carried out to children and parents of elementary school students.

References

Alem, K.D., & Gebru, E.A., 2021. A Cross-Sectional Analysis of RE Prevalence and Associated Factors Among Elementary School Children in Hawassa, Ethiopia. *Journal of International Medical Research*, 49(3).

Angmalisang, Y.S.A., Moningka, M.E.W., & Rumampuk, J.F., 2021. Hubungan Penggunaan Smartphone terhadap Ketajaman Penglihatan. *Jurnal e-Biomedik*, 9(1), pp.94–100.

Al Bahhawi, T., Makeen, A.M., Daghreeri, H.H., Tobaigy, M.F., Adawi, A.M., Guhal, F.M.,

Akkur, M.A., Alotayfi, M.J., Otayf, M.M., Bajoned, M.S., & Mahfouz, M.S., 2018. Refractive error Among Male Primary School Students in Jazan, Saudi Arabia: Prevalence and Associated Factors. *The Open Ophthalmology Journal*, 12(1), pp.264–272.

Al Wadaani, F.A., Amin, T.T., Ali, A., & Khan, A.R., 2013. Prevalence and Pattern of Refractive Errors Among Primary School Children in Al Hassa , Saudi Arabia. *Global Journal of Health Science*, 5(1), pp.125–134.

Budiono, I., Hermawati, B., Rochmayani, D.S., & Fauzi L., 2024. Nutritional Literacy as An Effect Modifier on Undernutrition Incidence among Poor Urban Family in Semarang City. *Kemas*, 19(3), pp.480–489.

Chu, G.C.H., Chan, L.Y.L., Do, C., Tse, A.C.Y., Cheung, T., Szeto, G.P.Y., So, B.C.L., Lee, R.L.T., & Lee, P.H., 2023. Association between Time Spent on Smartphones and Digital Eye Strain: A 1-Year Prospective Observational Study Among Hong Kong Children and Adolescents. *Environmental Science and Pollution Research*, 30(20), pp.58428–58435.

Do, C., Chan, L.Y.L., Tse, A.C.Y., Cheung, T., So, B.C.L., Tang, W.C., Yu, W.Y., Chu, G.C.H., Szeto, G.P.Y., Lee, R.L.T., & Lee, P.H., 2020. Association between Time Spent on Smart Devices and Change in Refractive Error: A 1-Year Prospective Observational Study Among Hong Kong Children and Adolescents. *International Journal of Environmental Research and Public Health*, 17(23), pp.1–11.

Enthoven, C.A., Polling, J.R., Verzijden, T., Tideman, J.W.L., Al-Jaffar, N., Jansen, P.W., Raat, H., Metz, L., Verhoeven, V.J.M., & Klaver, C.C.W., 2021. Smartphone Use Associated with REin Teenagers: The Myopia App Study. *Ophthalmology*, 128(12), pp.1681–1688.

Ezhilvathani, N., Suruthi, P., & Jeiganesh, M., 2019. Profile of Refractive Errors and Amblyopia in 5-15 Years of School Going Children at a Union Territory Tertiary Health Centre. *International Journal of Research in Medical Sciences*,7(5), pp.1929.

Foreman, J., Salim, A.T., Praveen, A., Fonseka, D., Ting, D.S.W., He, M.G., Bourne, R.R.A., Crowston, J., Wong, T.Y., & Dirani, M., 2021. Association between Digital Smart Device Use and Myopia: A Systematic Review and Meta-Analysis. *The Lancet Digital Health*, 3(12), pp.e806–e818.

Gao, Z., Meng, N., Muecke, J., Chan, W.O., Piseth, H., Kong, A., Jnguyenphamhh, T., Dehghan, Y., Selva, D., Casson, R., & Ang, K., 2012. Refractive Error in School Children in an Urban and Rural Setting in Cambodia. *Ophthalmic Epidemiology*, 19(1), pp.16–22.

Hashemi, H., Fotouhi, A., Yekta, A., Pakzad, R., Ostadimoghaddam, H., & Khabazkhoob, M., 2018. Global and Regional Estimates of Prevalence of Refractive Errors: Systematic Review and Meta-Analysis. *Journal of Current Ophthalmology*, 30(1), pp.3–22.

Jaiswal, S., Asper, L., Long, J., Lee, A., Harrison, K., & Golebiowski, B., 2019. Ocular and Visual Discomfort Associated with Smartphones, Tablets and Computers: What We Do and Do Not Know. *Clinical and Experimental Optometry*, 102(5), pp.463–477.

Jones-Jordan, L.A., Sinnott, T., Manny, R.E., Cotter, S.A., Kleinstein, R.N., Mutti, D.O., Twelker, D., & Zadnik, K., 2010. Early Childhood Refractive Error and Parental History of Myopia as Predictors of Myopia. *Investigative Ophthalmology and Visual Science*, 51(1), pp.115–121.

Kemenkes., 2019 *Hasil Utama Riset Kesehatan Dasar 2018*. Jakarta: Kementerian Kesehatan RI.

Khouj, G., Alharbi, A., Alghamdi, W., Alzahrani, Y., & Fallata, A., 2023. Uncorrected Refractive Errors Among Children Attending Pediatric Ophthalmology Clinic at Security Forces Hospital, Makkah, Saudi Arabia. *Cureus*, 15(3), pp.1–8.

Lanca, C., & Saw, S.M., 2020. The Association Between Digital Screen Time and Myopia: A Systematic Review. *Ophthalmic and Physiological Optics*, 40(2), pp.216–229.

Lim, L.T., Gong, Y., Ah-Kee, E.Y., Xiao, G., Zhang, X., & Yu, S., 2014. Impact of Parental History of Myopia on the Development of Myopia in Mainland China School-Aged Children. *Ophthalmology and Eye Diseases*, 6(1), pp.31–35.

Lindquist, A.C., Cama, A., & Keeffe, J.E., 2011. Screening for Uncorrected Refractive Error in Secondary School-Age Students in Fiji. *Clinical and Experimental Ophthalmology*, 39(4), pp.330–335.

Okafor, F.C.M., Okoye, O., Ezegwui, I., Oguego, N.C., Okoye, O.I., Udeh, N., Aghaji, A.E., Nwobi, E., Aneji, C., Onwasigwe, E., & Umeh, R.E., 2021. Refractive Error and Visual Impairment Among School Children: Result of A South-Eastern Nigerian Regional Survey. *Clinical Ophthalmology*, 15, pp.2345–2353.

Paudel, P., Ramson, P., Naduvilath, T., Wilson, D., Phuong, H.T., Ho, S.M., & Giap, N.V., 2014. Prevalence of Vision Impairment and

Refractive Error in School Children in Ba Ria - Vung Tau Province, Vietnam. *Clinical and Experimental Ophthalmology*, 42(3), pp.217–226.

Rezvan, F., Khabazkhoob, M., Fotouhi, A., Hashemi, H., Ostadimoghaddam, H., Heravian, J., Azizi, E., Khorasani, A.A., & Yekta, A.A., 2012. Prevalence of Refractive Errors Among School Children in Northeastern Iran. *Ophthalmic and Physiological Optics*, 32(1), pp.25–30.

Rochmayani, D.S., & Cahyaningsih, O., 2021. Risk Factors for the Incidence of Computer Vision Syndrome (CVS) in Lecturers During the Online Learning Period', *Journal of Health Education*, 6(2), pp.65–72.

Santiago, H.C., Rullan, M., Ortiz, K., Rivera, A., Nieves, M., Pina, J., Torres, Z., & Mercado, Y., 2023. Prevalence of Refractive Errors in Children of Puerto Rico. *International Journal of Ophthalmology*, 16(3), pp.434–441.

Sharma, A., Congdon, N., Patel, M., & Gilbert, C., 2012. School-based Approaches to the Correction of REin Children. *Survey of Ophthalmology*, 57(3), pp.272–283.

Sharma, I.P., Lepcha, N.T., Lhamo, T., Ellwein, L.B., Pokharel, G.P., Das, T., Sapkota, Y.D., Dorji, T., & Peldon, S., 2020. Visual Impairment and Refractive Error in School Children in Bhutan: The Findings from the Bhutan School Sight Survey (BSSS 2019). *PLoS ONE*, 15(9), pp.1–12.

Wang, M., Cui, J., Shan, G., Peng, X., Pan, L., Yan, Z., Zhang, J., Zhong, Y., & Ma, J., 2019. Prevalence and Risk Factors of Refractive Error: A Cross-Sectional Study in Han and Yi adults in Yunnan, China. *BMC Ophthalmology*, 19(1), pp.1–12.

Wang, Y., Liu, L., Lu, Z., Qu, Y., Ren, X., Wang, J., Lu, Y., Liang, W., Xin, Y., Zhang, N., Jin, L., Wang, L., Song, J., Yu, J., Zhao, L., Ma, X., & Zhang, L., 2022. Rural-Urban Differences in Prevalence of and Risk Factors for Refractive Errors Among School Children and Adolescents Aged 6–18 Years in Dalian, China. *Frontiers in Public Health*, 10.

Worku, S., Getachew, T., Nagarchi, K., Shewangizaw, M., 2023. The Magnitude of Refractive Error and Its Associated Factors Among Patients Visiting Ophthalmology Clinics in Southern Ethiopia, 2022. *Clinical Ophthalmology*, 17(June), pp.1801–1811.