ORIGINAL ARTICLE

AN OVERVIEW OF REFRACTIVE ERRORS AMONG CHILDREN IN KOTA SOE DISTRICT, INDONESIA

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ABSTRACT

Introduction: *Refractive error is one of the most common preventable causes of blindness in the world. Screen time and outdoor time are known as risk factors for its prevention. This study aims is to show the prevalence of children's refractive error and the difference between screen time and outdoor time.*

Methods: *This study used a cross-sectional design to examine children's refractive error from 10 to 14 years old at five child development centers located across SoE from March 2020 to August 2021. Screen time and outdoor time data were obtained using a questionnaire, grouped into low-medium and high groups, and analyzed the differences between groups.*

Result: *In this study, there are 429 participants with an average age* of 12.65 ± 1.44 years old. The prevalence of refractive error is *9.56% and the most common error is mild myopia (43.59%). Refractive error in females is more common than in males (75.61%) and distributed in all age groups.* There is no significant difference between refractive error prevalence and the amount of screen time (t 0.500; p: 0.480) and outdoor time (t: 0.944; p: 0.331).

Conclusion: *The most common refractive error in this study is mild myopia. There is no refractive error prevalence difference in screen time and outdoor time.*

Keywords: *refractive error, myopia, screen time, outdoor time*

INTRODUCTION

The visual system in human life is vital in environmental awareness by receiving, processing, and interpreting light.[1,2] One of the most common abnormalities occurred is the refractive error or ametropia, which is the second leading preventable blindness globally.[3] It caused visual disruption due to unfocused light rays in the retina.

Refractive error is classified into myopia, hyperopia, and astigmatism.[4] Myopia occurred when the light rays focus in front of the retina due to the longer eye's axial length or higher lens/ cornea's refractive power.[2,4] In reverse, shorter axial length or lesser lens/cornea's refractive power in hyperopia causes the light rays to focus behind the retina.[5] Astigmatism occurs if the light rays do not focus in one spot on the retina.[4] Visual disruption due to uncorrected refractive error has short and long consequences, such as decreasing opportunities for school and work, joblessness, decreasing quality of life.[6]

From time to time, the prevalence of refractive error globally is increasing.[7] Holden et al. predicted that by 2050, around 4.8 billion people worldwide will have myopia and 938 million people with severe myopia.[8] A study in Mexico by Gomez-Salazar et al. showed that 40.9% of 10-19 group ages have myopia which keeps increasing.[9] Another study in Bandung showed that 15.9% of school-age students have refractive error, and 12.1% of them have not corrected it yet.[10]

From another perspective, we also need to look at the risk factors of the refractive error which include the unmodifiable, such as genetics and race, and the modifiable, such as environment and habits.[11] Screen time and outdoor time are two environmental factors that affect the error greatly. [12] The more time on screen and the lesser time outdoor, the higher risk of contracting refraction error.[13]

One cohort study in the Netherlands showed that 11.5% of children had myopia and were affected significantly by near-work and outdoor exposure. Nonetheless, in Indonesia, especially in the eastern region, the information about visual acuity and its error is minimal. This finding is vital, especially for the pediatric age group who depend on visual healthiness for development and education. The affecting factors need to be identified, especially the modifiable factors, for preventable action. Therefore, this study is conducted to identify the characteristics of children's visual acuity in the Kota SoE district, Timor Tengah Selatan regency, and to compare the number of refractive errors based on screen time and outdoor time groups.

METHODS

This observational study with a cross-sectional design was conducted from March 2020 to August 2021. This study has permission from *Penanaman Modal dan Pelayanan Terpadu Satu Pintu* Service in Timor Tengah Selatan Regency with letter number DPMPTP.22.03.1/057/III/2020. This study was conducted with informed consent to the participants' guardians and participant which asssigned by both of them.

The subjects were 10-14 years old children in Kota SoE district. This study used randomized sampling in four children development centers across Kota SoE district. Oemathonis, Imanuel SoE, Joshua Kids, and Jireh were the four centers**.** Samples were taken based on these inclusion criteria: 10-14 years old, able to read, and voluntarily join this study. The exclusion criteria were inability to communicate well and contracting eye disorders like strabismus.

This study started by participants answer the questions about screen time and sun-exposed outdoor time that is modified from Enthoven et al. study. The questionnaires can be read in

Appendix 1. Screen time was asked in two separate questions represented on weekdays and weekends. It was measured by the sum of 5 weekdays and 2 weekends that will show one week of screen time. Outdoor time was asked in three separate questions measured by summing all the amount of outdoor activities time in sun-exposed conditions. The screen time result was grouped into low (<5 hours/week), medium (5-10 hours/week), and high (>10 hours/week), while outdoor time into low (<7 hours/week), medium (7-14 hours/week), and high (>14 hours/week).[12]

Afterward, visual acuity (VA) was measured using the Snellen chart without cycloplegic drops. If the VA was less than 20/20, the examination would proceed to objective measurement using auto-refractometer *Essilor AKR 400* and re-confirmed subjectively by the trial lens. The right eye was checked first before the left one.

The operational definition of refractive error uses spherical equivalent/ SE. Myopia is defined by minimal -0.50 D SE; hyperopia by minimal +2.00 D SE, and astigmatism by minimal -0.50 D SE. Myopia is grouped by its severity into mild (-0.50 D to -3.00 D), moderate (-3.00 D to -6.00 D), and high (>-6.00 D). Astigmatism is grouped into simple myopia astigmatism, compound myopia astigmatism, simple hyperopia astigmatism, compound hyperopia astigmatism, and mixed astigmatism. Anisometropia is defined as ≥ 1 D SE differences between eyes.[16]

The sample size was determined by using Slovin's formula $n = \frac{N}{1+Ne^2}$ where n was the minimal sample size, N was the population, e was the 0.05 error margin.[14] The 10-14 years old children population was 4,625 people based on the data from *Badan Pusat Statistik* Timor Tengah Selatan in 2009.[15] Based on this formula, the n was 368 people.

VA characteristics were shown in demographic data and prevalence comparison in screen time and outdoor time. Demographic data showed the number of participants, data distribution by gender, age, diagnosis, refractive power laterality, and previous refractive correction. The Pearson chi-square method tested comparison data using IBM SPSS 26 version software.

RESULTS

Table 1 showed the data distribution of children by gender and refractive error. The number of participants was 429 people who met the inclusion criteria. 197 people (45.92%) were male, and 232 people (54.08%) are female. The participants were distributed from 10 years to 14 years 9 months old, and the average age was 12.65 ±1,44 standard deviation. Of the

number of refractive errors or ametropia, 41 people (9.56%) and 9.76% had anisometropia (4 people). Of 41 people with refractive error, only two (5.13%) had been corrected by glasses.

Table 1. Demographic Data

Variable	Total (n=429), n (%)
Age, in year (mean ± standard deviation)	12.65 ± 1.44
Gender	
Male	197 (45.92%)
Female	232 (54.08%)
Refractive Error	
Emetropia	388 (90.44%)
Ametropia	41 (9.56%)
Refractive Power Laterality	
Isometropia	37 (90.24%)
Anisometropia	4 (9.76%)
Correction History	
Glasses	2 (5.13%)
Without Glasses	39 (94.87%)

Figure 1 showed data distribution by gender. Refractive error was found more in females (31 people, 75.61%) than males (10 people, 24.39%). The most found diagnosis is mild myopia (43.59%), followed by compound myopia astigmatism (29.49%). Figure 2 described case distribution by age. Mild myopia was found the most in the 11 and 14 age groups, while compound myopia astigmatism in the 10 and 13 age groups. In 12 age group, the percentage of mild myopia was equal to compound myopia astigmatism. Compound hyperopia astigmatism was the least number of diagnoses in this study (1 case). Figure 3 showed that 19 of 41 people have best-corrected VA (BCVA) less than 20/20. The most number of BCVA is 20/30 with 10 people.

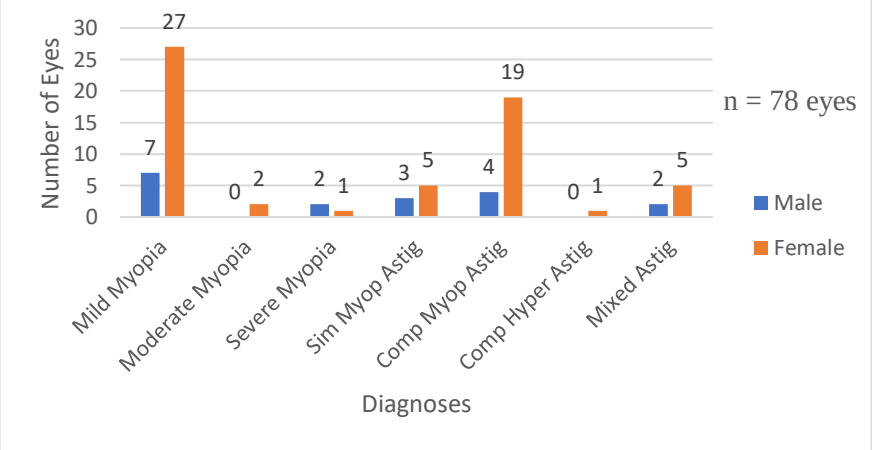

Figure 1. Diagnosis Distribution by Gender.

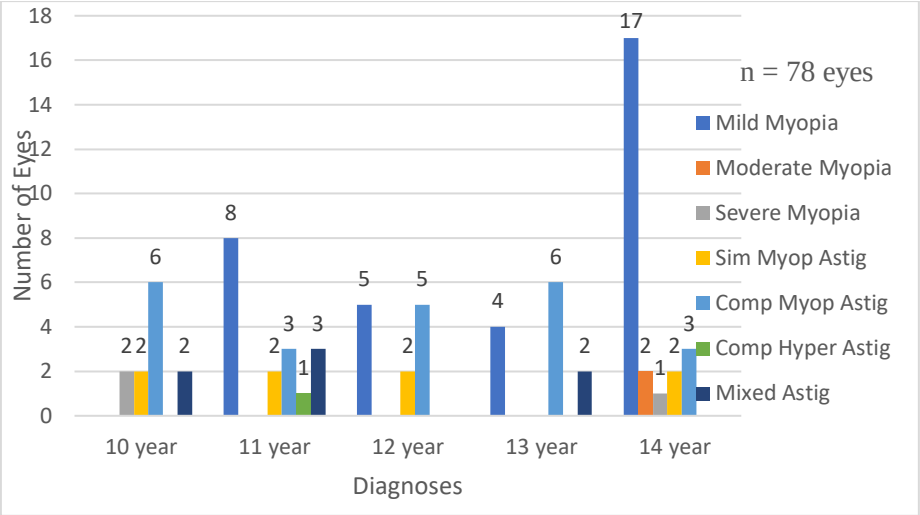

Figure 2. Diagnosis Distribution by Age.

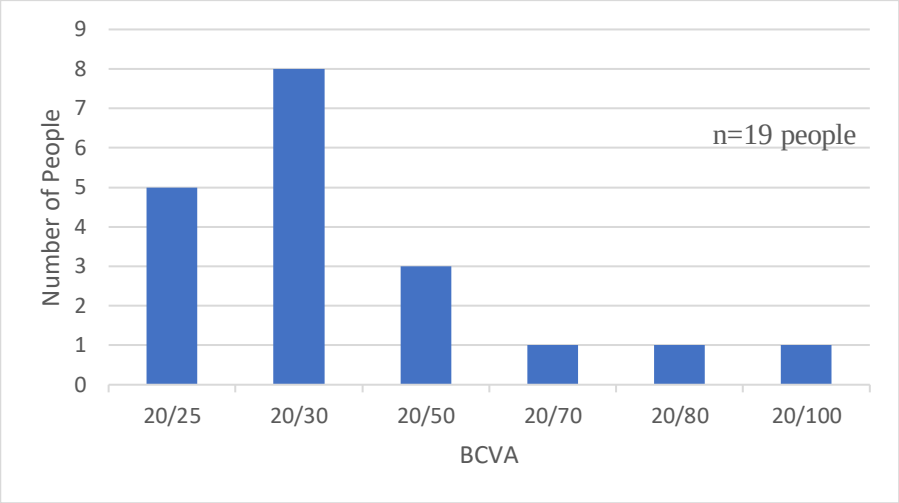

Figure 3. Best Corrected Visual Acuity.

Table 2 compared of the number of refractive errors between children with mild-moderate and high screen time and outdoor time. The time grouping was modified because of the lack of samples in the mild category. The chi-square test result showed no significant difference between the number of refractive errors in mild-moderate screen time and high screen time (Pearson 0.500, p-value 0.480). The same result was shown in the outdoor time chi-square test with Pearson 0.944 and p-value 0.331.

Table 2. Comparison of Refractive Error in Screen Time and Outdoor Time

		Diagnoses			Pearson X^2
		Emetropia	**Ametropia**	**Total**	**(P value)**
Screen Time	Mild-Moderate	144	13	157	
	High	242	28	270	
Total		386	41	427	0.500(0.480)
		Emetropia	**Ametropia**	**Total**	**Pearson X^2 (P value)**
Outdoor Time	Mild-Moderate	113	15	128	
	High	273	26	299	
Total		386	41	427	0.944(0.331)

DISCUSSION

This study found that 9.56% of children in Kota SoE district, a rural region in Indonesia, have refractive error. This finding is less than another study in Bandung City, Indonesia's urban population, which found a greater prevalence (18.39%) than in this study.[16] This finding is in line with the study of Tang et al. in China, who showed greater prevalence in the urban area than in the rural area.[17] One of the suspected risk factors is better education in the urban area. Higher education levels in the urban area will demand more time for reading or any near-work activity.[18]

By gender, the refractive error frequency is higher in females than males (75.61%: 24.39%). This finding aligns with the study in China showed higher refractive error prevalence in females.[19] Another study by Jones-Jordan et al. found that myopia in females tends to progress faster than in males.[20] Females are thought to have lesser outdoor time or more near-work activities.[21]

The most common refractive error found is mild myopia in male and female children. A similar finding by Gomez-Salazar et al. in Mexico showed that myopia is the most common refractive error in the 10-29 age group.[9] Yam et al. showed a higher prevalence (25%) in the 6-8 years old children in Hong Kong.[22] Without significant intervention from all stakeholders, this will be a huge health burden to society.[23] Some actions could be done to slow down myopia progression in children, such as topical anti-muscarinic, using the multifocal lens in glasses or contact lenses, and orthokeratology contact lenses.[24]

The most frequent astigmatism in this study is compound myopia astigmatism. Li et al. found the prevalence of astigmatism at 12.7% in the 4-6 age groups.[25] During the Covid-19 lockdown in 2020, Liang et al. studied the effect of learning activities at home on the prevalence of astigmatism and found 1.5 times more escalating cases than 2 previous years and a significant increase in astigmatism corrective power.[26]

This study found no hyperopia and 1 child with compound hyperopia astigmatism (1.28%). Galvis et al. found a different result where hyperopia peaked at 10 years old, while Tang et al. found hyperopia prevalence was low in China.[27,17] The possible factors contributing to these contradictory findings are environment, for example, near-work time and outdoor time, ethnicity, genetics.[17] Furthermore, this study has limitations because of the non-cycloplegic VA examination.[28]

Anisometropia is found in 9.76% of this study. This finding is consistent with the study by Deng & Gwiazda that found that 9.64% of myopia cases and 13.64% of hyperopia cases have anisometropia.[29] Hu et al. found factors like age, parent's education level, and outdoor time contribute to anisometropia incidence.[30]

Most visual impairments can be corrected with glasses, but only 5.13% of the participants have used them. This finding aligns with a study in Mexico that reported the refractive error as the main visual impairment in the rural area, which can be corrected but still become a burden.[31] A study by Thom et al. in Malawi found amblyopia as the cause for significant VA decline in school-age children besides refractive error.[32]

In this study, there is no significant difference between the number of refractive errors in mild-moderate and high screen time (t 0.500; p: 0.480) and outdoor time (t: 0.944; p: 0.331). Lanca & Saw, in their meta-analysis, showed there was no significant correlation between screen time and refractive error. These findings may be affected by bias from the measurement methods, for example, a questionnaire, that contribute to the objectivity.[33] Concerning this, Wen et al. used an objective measurement tool to count the eye-object distance and light illumination. They found the protective effect of light with >3000 lux intensity and near-work (< 20 cm) time as the risk factor for myopia.[34] Outdoor time, in a study by Cao et al., was shown to have a protective effect on non-myopic children and reduce the progression of refractive error and axial length.[35] Guan et al. found the perfect time to get this protective effect is at noon for 31-60 minutes long.[36]

This study is the first pilot study of visual acuity in this district with large samples. On the other side, this study has some limitations. This study was conducted with a non-prospective design which can not identify the causative effect of the risk factors. Non-cycloplegic VA examination was done in this research, limiting the accuracy of the hyperopia diagnoses. The VA examination also used the Snellen chart instead LogMar chart, with limited access to the auto-refractometer due to limited resources. The possibility of recall bias from the questionnaire also can not be excluded.

CONCLUSION

Refractive error is still an undetected burden that impacts the communities quality of life, especially children. Mild myopia was the most common type of refractive error among the children, and only 5.13% have been corrected. The number of refractive errors does not differ significantly between mild-moderate and high screen time and outdoor time. Further studies are needed to evaluate the correlation between risk factors and refractive error; to research with a broader sample and age span, and to obtain data with more objective tools and methods for better and more comprehensive results. Hopefully, these findings will become inputs for the government and other stakeholders in preventing and treating of this problem.

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Appendix

1. Pada hari Senin sampai Jumat, berapa jam dalam sehari anda menggunakan gawai (smartphone / tablet / laptop / komputer)? (termasuk mengirim pesan singkat, media sosial, video call, bermain game)
   a. Tidak ada
   b. Kurang dari 1 jam / hari
   c. 1 – 2 jam / hari
   d. 3 jam atau lebih / hari
2. Pada hari Sabtu & Minggu, berapa jam dalam sehari anda menggunakan gawai (smartphone / tablet / laptop / komputer)? (termasuk mengirim pesan singkat, media sosial, video call, bermain game)
   a. Tidak ada
   b. Kurang dari 1 jam / hari
   c. 1 – 2 jam / hari
   d. 3 jam atau lebih / hari
3. Berapa jam dalam sehari anda berjalan kaki / bersepeda / berkendara sepeda motor yang terpapar sinar matahari?
   a. Tidak ada
   b. Kurang dari 1 jam / hari
   c. 1 – 2 jam / hari
   d. 3 jam atau lebih / hari
4. Berapa hari dalam seminggu anda berolahraga / melakukan hobi di luar ruangan yang terpapar sinar matahari? (Contoh : Berlari, voli, sepakbola, basket, bela diri, bermain di halaman, jelajah alam, fotografi luar ruangan, berkebun dan lain-lain)
   a. 0-2 hari per minggu
   b. 3-4 hari per minggu
   c. 5-6 hari per minggu
   d. 7 hari per minggu
5. Berapa jam waktu yang digunakan setiap kali berolahraga / melakukan hobi di luar ruangan yang terpapar sinar matahari?
   a. Tidak ada
   b. Kurang dari 1 jam / kegiatan
   c. 1 – 2 jam / kegiatan
   d. 3 jam atau lebih / kegiatan