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Prevalence of Refractive Error and Visual Impairment Among Schoolchildren in Klang Valley, Malaysia in Post-COVID-19 Era

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Refractive error is a critical aspect of child development, as uncorrected vision problems can impact a child's educational and social well-being. This study aims to discover the prevalence of refractive error and visual impairment as well as to investigate the distribution of refractive errors among schoolchildren attending public schools in the Klang Valley in post-COVID-19 era. The examinations conducted were visual acuity testing using the Snellen chart at 3 meters for distance, which was converted to LogMAR notation and the reading chart at 40 cm, cover test, and refraction. In this study, 945 schoolchildren between the ages of 7 and 15 were examined for refractive error. Of the 945 participants, 479 were males (50.7%) and 466 were females (49.3%). The mean age and (standard deviation) of participants was 10.67 (+1.29) years. Overall, the prevalence of refractive errors was 28.5% including 2.5% for hyperopia and 26% for myopia. The percentage of visual acuity of less than 6/6 was 18.2%. There is a need for public health initiatives to promote frequent eye check-ups and the potential long-term consequences of untreated refractive error.

Keywords: schoolchildren; prevalence; refractive error; visual impairment; COVID-19

I. INTRODUCTION

Refractive error stands as the primary reason for visual impairment globally, while myopia represents the largest category of refractive errors (Holden *et al.*, 2016). The World Health Organization (WHO 2021) reports that untreated refractive error creates visual impairment and blindness in approximately 88.4 million people worldwide, thus making it the leading preventable cause of blindness. Early detection of children's refractive errors, followed by corrective spectacles or therapies could prevent the occurrence of visual impairment. Untreated refractive errors result in lasting negative impacts on both academic progress and social development of children (Latif *et al.*, 2022).

Previous concerns regarding refractive error in children have been aggravated by the COVID-19 pandemic. The switch to online learning only added to both screen time and near-vision tasks like reading off digital devices, which can arguably be characterized as a huge increase in near-vision work. Previous studies continuously indicated that long-term near-vision activity, particularly screen time, aggravated the incidence rate of children's myopia (Huang *et al.*, 2015). The change in daily life, along with reduced outdoor settings and physical activity during lockdown, has led to an increase in myopia incidence, especially in regions where myopia had been reported before.

Research conducted after the pandemic revealed concerning patterns in child vision health. European children experienced a 50% increase in myopia development during quarantine (Grzybowski *et al.*, 2020), particularly among those with myopia family history. Research conducted in Asia revealed an increased rate of myopia among students after the pandemic (Ma *et al.*, 2022). The absence of scheduled eye tests during this period led to delayed diagnosis of refractive errors which may have resulted in extended negative impacts on children.

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Before the pandemic started, countries in East and Southeast Asia were already showing increased concern about the percentage of children whose vision is impaired by refractive errors. Chia *et al.* (2009) reported an epidemic level of myopia in Singapore which is similar to the situation in China and Japan. Grzybowski *et al.* (2020) stated that the rate of Singaporean children aged 6 developing myopia increased from 30% in 1990 to greater than 50% in 2015. This is also evident from studies indicating that myopia rates among Malaysian school children soared up from 23% in the 1980s, to almost 50% in the 2010s (Bakar *et al.*, 2012). In a study by Ismail & Sukumaran (2022), it was found that the prevalence of refractive error among schoolchildren was 47.8% with myopia being the highest at 30.2%, astigmatism was 16.3% and hyperopia was 1.2%.

The Klang Valley, which includes Kuala Lumpur and surrounding areas, is the primary population, economic, and cultural centre and one of the most densely populated and urbanised area in Malaysia. Also, the existing socioeconomic and environmental conditions in this area may play a role in developing and evolving vision problems in children (Kamaruddin *et al.*, 2022). The region has experienced fast-paced urbanization and lifestyle modifications that parallel the global rise in screen exposure and sedentary living, particularly in the children population. The prevalence of refractive error among Malaysian students had increased before the pandemic, which showed myopia to be higher in urban areas compared to the rural (Goh *et al.*, 2005; Hashim *et al.*, 2008). In the Klang Valley, the COVID-19 pandemic reinforces these concerns.

According to the Malaysian Ministry of Education (2021), when online learning took place, children spent more time using electronic devices, and their access to physical activities dropped significantly. The disrupted routines most likely contributed to increased prevalence of refractive errors among children. Ma *et al.* (2022) found that there was an increase in myopia development in Chinese school children who studied at home during the COVID-19 pandemic.

Limited studies have been done to report the prevalence of refractive error and visual impairment in Klang Valley after COVID-19. This gap in knowledge highlights the need for more research to investigate the impact of COVID-19 on the eye of schoolchildren, especially as the lifestyle implemented in large cities such as Klang Valley may vary considerably compared to those in rural areas. Therefore, it is important to examine the visual health status of school children in the Klang Valley.

This study aims to find out the prevalence of refractive error and visual impairment and to analyse the distribution of refractive errors, including myopia, hyperopia, and emmetropia, among school children who attended public schools in the Klang Valley post-COVID-19 pandemic. Additionally, the study will evaluate the association between demographic factors, such as age, gender, and ethnicity with refractive error and visual acuity.

II. MATERIALS AND METHOD

Nine hundred forty-five schoolchildren who attended public schools within the Klang Valley were enrolled in this study based on a purposive sampling design. The design of this study was a cross-sectional study, and the duration of the study was from August 2022 to October 2022 for collection of data. Approval to conduct the study was given by the UCSI Institutional Ethics Committee (Approval Number IEC-2021-FMHS-60). Before recruitment into the study, the researchers obtained consent from the parents or legal guardians of all schoolchildren. Only Malaysian schoolchildren were enrolled in this study. Children with physical, pathological, or cognitive disabilities or those undergoing treatment for ocular conditions were excluded to avoid confounding results. Basic demographic data were obtained during the registration process which involved age, gender, and ethnicity.

For the vision screening, several tests were conducted such as visual acuity (VA) testing using the standard high contrast Snellen chart at 3 meters for distance and reading chart at 40 cm for near, cover test, autorefraction with Topcon KR-800 Autorefractor Keratometer desktop machine and subjective refraction. Children who required vision correction were prescribed glasses. For the children who had ocular anomalies or difficulty performing non-cycloplegic refraction due to fluctuating accommodation responses were referred to the UCSI Eye Centre on different occasions. These children underwent further eye assessments and cycloplegic refraction, with glasses prescribed thereafter.

Children who had significant ocular anomalies that required ophthalmological interventions were referred accordingly.

Refractive error classification was based on the spherical equivalent (SE), calculated as the spherical power plus half of the cylindrical power. Myopia is defined as spherical equivalent (SE) of at least ≥ -0.50 D, hyperopia as SE > +0.50D, emmetropia, -0.50 < SE ≤ +0.50D. Amblyopia was defined as the best corrected VA worse than or equal to 6/9 using Snellen VA in the absence of ocular pathology.

A. Statistical Analysis

Data was analysed using Statistical Package for Social Sciences (SPSS version 27.0; IBM Corp, Armonk, NY, USA) software. For test of normality, the Kolmogorov-Smirnov test was used. The demographic data and prevalence of refractive errors were assessed using descriptive statistics. The results were reported as mean, standard deviation (SD), frequency, and percentage. Mann-Whitney U and Kruskal Wallis were used to compare spherical equivalent (SE) and LogMAR visual acuity across genders, age groups, and ethnicities. P-values of less than 0.05 were considered as statistically significant.

III. RESULT

A. Demographic Analysis

The study population consisted of 945 schoolchildren. From the total number of subjects 479 were males (50.7%) and 466 were females (49.3%). The mean (SD) age was 10.67 ±1.29 years. The overall prevalence of refractive errors was 28.5%. In terms of classification of refractive error, the prevalence for emmetropia was 71.5%, followed by 26% and 2.5% for myopia and hyperopia respectively. The prevalence was calculated based on the category of the spherical equivalent refractive error for the left eyes.

Table 1 shows the demographic data for ethnicity for the children with refractive errors. For ethnicity, Malay schoolchildren had a higher frequency compared to Indians and others. Table 2 shows the distribution of refractive error with age and Table 3 shows the frequency and age group for participants. The age group between 10-12 years old had the highest percentage of 77.5%.

Table 1. Frequency and percentage of ethnicity.

Ethnicity	Frequency	Percent
Malay	653	69.1
Indian	286	30.3
Others	6	0.6
Total	**945**	**100**

Table 2. Frequency and percentage for the age of participants.

Age	Frequency	Percent
7	14	1.5
8	9	1.0
9	152	16.1
10	251	26.6
11	252	26.7
12	229	24.2
13	19	2.0
14	13	1.4
15	6	0.6
Total	**945**	**100**

Table 3. Frequency and percentage of age group.

Age group	Frequency	Percentage
7-9 years	175	18.5
10-12 years	732	77.5
13-15 years	38	4
Total	**945**	**100**

B. Prevalence of Refractive Error

Tables 4 and 5 display the category for spherical equivalent refractive error for right and left eyes. For prevalence, the left eye data was taken into consideration with 26% exhibiting refractive errors with myopia as the most prevalent type and hyperopia at 2.5%. The majority had emmetropia with 71.5%. This finding underscores the increasing prevalence of refractive errors among children, particularly myopia, which has become a significant public health concern.

Table 4. Category of spherical equivalent refractive error for the right eye

Refractive error	Frequency	Percentage
Myopia	258	27.3
Hyperopia	23	2.4
Emmetrope	664	70.3
Total	**945**	**100**

Table 5. Category of spherical equivalent refractive error for the left eye

Refractive error	Frequency	Percentage
Myopia	246	26
Hyperopia	23	2.5
Emmetrope	676	71.5
Total	**945**	**100**

C. Category of Visual Acuity

Table 6 displays the category and percentage of visual acuity for the left eye. The left eye was chosen due to the better visual acuity of this eye. The percentage of visual acuity achieving 6/6 or better after refraction was 81.8%. The percentage of visual acuity lower than 6/6 was 18.2%. It was found that 15.8% of the schoolchildren had visual acuity between 6/6 and 6/12, and 1.7% had visual acuity less than 6/60.

Table 6. Category of visual acuity for Left eye

Visual Acuity (VA)	Frequency	Percentage (%)	VA Category
6/6 and better	773	81.8	Good
<6/6 – 6/12	149	15.8	Mild
<6/12 – 6/18	5	0.5	Moderate
<6/18 – 6/60	2	0.2	Moderate-Severe
<6/60	16	1.7	Severe
Total	**945**	**100**	

D. Mean and Standard Deviation for SE and LogMAR VA among Gender and Ethnicity

Table 7 shows the mean and standard deviation for Spherical Equivalent (SE) and LogMAR VA on the right and left eye among genders while Table 8 displays the mean and standard deviation for SE and LogMAR VA on the right and left eye among ethnicities.

Table 7. Mean and Standard Deviation for SE Ref Error and LogMAR VA in right and left eye in gender

Gender		SEOD	SEOS	LogMAR VAOD	LogMAR VAOS
Male	Mean	-0.50	-0.45	0.03	0.03
	N	479	479	479	479
	Std. Deviation	1.22	1.34	0.08	00.09
	Minimum	-9.50	-9.50	-0.10	-0.20
	Maximum	5.00	12.25	0.70	0.70
Female	Mean	-0.61	-0.57	0.05	0.04
	N	466	466	466	466
	Std. Deviation	1.53	1.44	0.13	0.12
	Minimum	-10.50	-11.50	-0.10	-0.10
	Maximum	5.50	1.50	1.60	1.60

Table 8. Mean and Standard Deviation for SE Ref Error and LogMAR VA in RE and LE in ethnicity

Ethnicity		SEOD	SEOS	LogMAR VAOD	LogMAR VAOS
Malay	Mean	-0.65	-0.60	0.05	0.05
	N	653	653	653	653
	Std. Deviation	1.47	1.48	0.12	0.12
	Minimum	-10.50	-11.50	-0.10	-0.20
	Maximum	5.50	12.25	1.60	1.60
Indian	Mean	-0.34	-0.31	0.01	0.01
	N	286	286	286	286

	Std. Deviation	1.15	1.15	0.06	0.05
	Minimum	-10.50	-11.00	0.00	0.00
	Maximum	1.75	1.50	0.40	0.40
	Mean	-0.10	0.04	0.07	0.08
	N	6	6	6	6
Others	Std. Deviation	0.34	0.20	0.10	0.13
	Minimum	-0.75	-0.25	0.00	0.00
	Maximum	0.25	0.38	0.20	0.30

E. Mann Whitney and Kruskal Wallis Tests among Gender, Ethnicities and Age Group

Tables 9 show the Mann-Whitney test for SE refractive error and LogMAR VA in Right Eye and Left Eye among gender. Tables 10 and 11 show the Kruskall Wallis test for SE refractive error and LogMAR VA in Right Eye and Left Eye among ethnicity, and age groups. Mann-Whitney shows, gender had a significant difference for LogMAR VA in the right and left eyes, with a p-value of <0.05. Female had a higher LogMAR VA as compared to male in both right and left eyes. However, Mann-Whitney among genders for SE in right and left eyes show no significant differences with p-value > 0.05. As for the ethnicity, a significant difference was found for SE and LogMAR VA in the right and left eye, where the Kruskal Wallis among ethnicities and age groups was $p < 0.05$. Malay ethnicity had the highest SE and LogMAR VA as compared to Indian and others.

Table 9. Mann-Whitney test for spherical equivalent refractive error and LogMAR VA in Right and Left eye among gender.

Details	**SEOD**	**SEOS**	**LogMAR VAOD**	**LogMAR VAOS**
Mann-Whitney U	110643.5	111264.5	103184.0	104480.5
Z	-0.26	-0.09	-2.95	-2.53
P value	0.79	0.93	0.003	0.012

Table 10. Kruskal Wallis test for spherical equivalent refractive error and LogMAR VA in Right and Left eye among ethnicity

Details	**SEOD**	**SEOS**	**LogMAR VAOD**	**LogMAR VAOS**
Kruskal Wallis H	12.87	18.197	25.18	23.29
df	2	2	2	2
P value	0.002	<0.001	<0.001	<0.001

Table 11. Kruskal Wallis test for spherical equivalent refractive error and LogMAR VA for Right and Left eye among age groups

Details	**SEOD**	**SEOS**	**LogMAR VAOD**	**LogMAR VAOS**
Kruskal Wallis H	63.04	63.43	16.74	11.89
df	2	2	2	2
P value	<0.001	<0.001	<0.001	0.003

For refractive error, the Mann-Whitney U test showed no statistically significant differences between males and females. However, a significant difference was found for LogMAR VA in the right eyes ($p = 0.003$) and left eyes ($p = 0.012$) among genders. The Kruskal Wallis test showed significant in spherical equivalent ($p<0.001$) and LogMAR (Logarithm of Minimum Angle of Resolution) VA ($p<0.001$) in both right and left eyes between ethnicities., whereby Malay ethnicity shows the higher prevalence. The Kruskal Wallis test showed significant differences in spherical equivalent and LogMAR VA in the right and left eye between age groups. This indicates the amount of refractive error increases with age.

IV. DISCUSSION

In this study, we have presented the prevalence of refractive errors among schoolchildren which also seen to be aligned with various studies reporting increasing trend. This has shown to be related with increased use of digital devices, decreased time for outdoor activities, and hereditary influence (Wu *et al.*, 2018).

Our data shows prevalence of refractive errors to be 28.5%. The prevalence for hyperopia is 2.5%, for myopia is 26%, and for emmetropia is 71.5%. These findings are constant to global rates which were seen in similar populations at various regions of the world. Saw et al., (2005) found a high percentage of myopia in Asian children, ranging from 20% to over 80% in certain urban areas. In a systematic review, Hashemi *et al.* (2018) found that the prevalence of hyperopia among schoolchildren was similar around 4.6% (95% CI: 3.9–5.2).

The mean refractive error among females was found to be higher than males, however the difference was not significant among our study population. This indicates that gender is probably not significant in affecting refractive error in our study. However, there were significant differences found in the LogMAR VA for both right and left eyes among genders, therefore, gender is significant in affecting LogMAR VA in this study. A study in Singapore which has the racial distribution of students similar to Malaysia reported the same findings (Karuppiah *et al.*, 2021). They reported female students having higher rates of myopia as compared to males, but the association of gender with myopia remains debatable globally.

On other hand, we found the refractive error to be significantly different among ethnicity groups, with Malay students reported to have higher mean as compared to Indian, and others. This indicates that ethnicity is suggested to be a significant factor in influencing the development of refractive error. As per the global studies within the Asian regions, Chinese population is well known to have higher prevalence of refractive error followed by Malays and Indians. Therefore, our study shows supportive evidence of the trend within the ethnicity groups, despite the absence of Chinese population, given the national primary schools were chosen as the study location.

The findings of our study emphasise that in the absence of early identification and management of the refractive error, this could contribute to the visual impairment among the children. This situation subsequently can impact their education, lower self-esteem, and quality of life. Children with uncorrected refractive errors may be unable to read the board or books and participate in physical activities. This leads to poor academic performance and no social life (Prabhu *et al.*, 2019).

With periodic intervention, visual impairment from uncorrected refractive error may be prevented. However, no intervention may result in uncorrected refractive error, and no refractive corrections are provided in some countries, despite widespread access to eye care examinations (Cheong *et al.*, 2014). Refractive errors are among the primary causes of avoidable blindness and visual impairment worldwide, with estimates that over 12 million children globally have uncorrected refractive errors, according to WHO (2019). During the time of post-COVID-19 pandemic, myopia has increased tremendously. Saraa *et al.* (2022) found a notable rise in the prevalence of myopia in schoolchildren following the pandemic.

Different Asian countries reported poor visual acuity rates in a wide range among school children. Globally, a significant risk factor for poor visual acuity in children is uncorrected refractive error. The condition causes deterioration of vision and has negative impacts for academic performance and the quality of life in children. Amblyopia is a common paediatric visual impairment with a worldwide incidence rate of 1.44–4.3% (Wardati *et al.*, 2024).

The conditions are a product of complex interactions between genetic and environmental, and social determinants that are influenced by geographical and ethnic backgrounds. As the poor visual acuity prevalence rate in Malaysia has been quite variable over the years (Wardati *et al.*, 2024). A prevalence of 2.5% in primary school children was found in a study conducted on the East Coast of Peninsular Malaysia (Wardati *et al.*, 2024).

However, these results were contrasting with Segamat, Johor data, which reported a much higher prevalence (7.53%) in preschool children aged four to six years (Chew *et al.*, 2018). Such discrepancies are attributed to the

variations and diversity in screening modalities for each age group as well as the quality of eye care services available regionally across Malaysia. Preschool screening is not as frequently done as for other ages, so in some cases, this time gap can delay detection and treatment.

Additionally, a study found the overall reduced best-corrected visual acuity prevalence was 0.74% in school-aged children, but the prevalence of poor visual acuity varied greatly between ethnic groups: 1.43% in Hispanic, 0.93% in Chinese, 0.62% in Indian, 0.52% in Malay, 0.35% in Nepali, and 0.28% in African children, as shown in a study by Xiao *et al*. (2015). There may be genetic predisposition and differences in environmental exposure and lifestyle factors when it comes to the ethnic role in poor visual acuity susceptibility, as confirmed by study results.

The absence of regular eye examinations conducted on a more frequent basis during the pandemic is believed to have resulted in delayed diagnosis, while most school children were not able to receive adequate measures to address refractive errors in a timely manner. The consequences of disrupted treatment together with the lifestyle shifts, could also contribute to an increase in visual impairment in school children some years after the pandemic (Saraa *et al*., 2022).

Because uncorrected refractive errors impact children's academic performance, social development, and quality of life, the study results support the need to address the silent epidemic of uncorrected refractive errors. If not treated, mild visual defects can create difficulties with reading materials, which in turn can affect long-term cognitive development. There is a requirement for health awareness and community education on the importance of eye examination, and the repercussions of uncorrected refractive error also need to be undertaken.

The results of this study can help develop specific interventions and policies to address vision issues in schoolchildren of the Klang Valley through a thorough analysis of visual health in this population. Early detection and management of refractive error is crucial to ensure optimal vision development and improved academic performance in children.

A. Limitations

This study highlights the alarming prevalence of refractive error among school children. However, as with every other study, this study inherent some limitations. The study provides a snapshot of refractive errors at a single point in time and does not track changes or progression over time. Besides, the study focuses on gender differences and their association with refractive error; however, there was no data for the Chinese population.

B. Recommendations and Suggestions

The study may not represent all schoolchildren in Malaysia, as it focuses only on Klang Valley, which has urban and suburban populations, but may not reflect rural areas. Therefore, future studies should be expanded to include schoolchildren from Chinese Ethnicity and rural areas and other states in Malaysia to provide a more comprehensive national perspective. Furthermore, additional research is recommended to conduct extended studies to track the progression of refractive errors and the effectiveness of early interventions such as corrective lenses, outdoor activities, or digital screen time reduction. In future studies, it would be useful to explore how aspects of lifestyle, including screen time, reading, outdoor activity, diet, and genetics, affect the refractive error.

V. CONCLUSIONS

Our study emphasises the relevance of public health initiatives, along with in-school eye screening programs, which may help inform and improve educational awareness regarding the significance of frequent eye checks as well as the possible long-term consequences of untreated refractive error. Early diagnosis and management of refractive errors are vital in preventing vision-related complications and ensuring optimal academic and social development.

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VII. REFERENCES

Bakar, NF, Chen, AH, Noor, AR & Goh, PP 2012, 'Comparison of refractive error and visual impairment between Native Iban and Malay in a formal government school vision loss prevention programme', The Malaysian Journal of Medical Sciences: MJMS, vol. 19, no. 2, pp. 48–55. doi: 10.21315/mjms2012.19.2.6.

Chia, A, Dirani, M, Chan, YH & Gazzard, G 2009, 'Prevalence of refractive errors in Singaporean schoolchildren', Investigative Ophthalmology & Visual Science, vol. 50, no. 1, pp. 277-283. doi: 10.1167/iovs.09-3587.

Cheong, MS, Lee, SW & Tan, GF 2014, 'Knowledge, attitude, and practice on childhood refractive errors among parents in Malaysia', BMC Public Health, vol. 14, no. 1, p. 255. doi: 10.3389/fpubh.2024.1373209.

Chew, FLM, Thavaratnam, LK, Shukor, INC, Ramasamy, S, Rahmat, J, Reidpath, DD, Allotey, P & Alagaratnam, J 2018, 'Visual impairment and amblyopia in Malaysian pre-school children - The SEGPAEDS study', The Medical Journal of Malaysia, vol. 73, no. 1, pp. 25–30.

Goh PP, Abqariyah Y, Pokharel, GP & Ellwein, LB 2005, 'Refractive error and visual impairment in school-age children in Gombak District, Malaysia', Ophthalmology, vol. 112, no. 4, pp. 678-85. doi: 10.1016/j.ophtha.2004.10.048.

Grzybowski A, Kanclerz P, Tsubota K, Lanca, C & Saw, SM 2020, 'A review on the epidemiology of myopia in school children worldwide', BMC Ophthalmol, vol. 20, no. 1, p. 27. doi :10.1186/s12886-019-1220-0.

Hashim, SE, Tan, HK, Wan-Hazabbah, WH & Ibrahim, M 2008, 'Prevalence of refractive error in Malay primary school children in suburban area of Kota Bharu, Kelantan, Malaysia', Annals of the Academy of Medicine, Singapore, vol. 37, no. 11, pp. 940–946.

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, vol. 30, no. 1, pp. 3-22. doi: 10.1016/j.joco.2017.08.009.

Holden, BA, Fricke, TR, Wilson, DA, Jong, M, Naidoo, KS, Sankaridurg, P, Wong, TY, Naduvilath, TJ & Resnikoff, S 2016, 'Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050', Ophthalmology, vol. 123, no. 5, pp. 1036–1042. doi: 10.1016/j.ophtha.2016.01.006.

Huang, HM, Chang, DS & Wu, PC 2015, 'The Association between Near Work Activities and Myopia in Children-A Systematic Review and Meta-Analysis', PloS One, vol. 10, no. 10, p. e0140419. doi: 10.1371/journal.pone.0140419.

Ismail, LA & Sukumaran, S 2022, 'Prevalence of refractive errors among school children in Wangsa Maju, Kuala Lumpur, Malaysia', Med. Hypothesis Discov. Innov. Optom., vol. 3, no. 3, pp. 106-112. doi: 10.51329/mehdioptometry158.

Kamaruddin, H, Nordin, N, Abdul Manap, NE, Narayanasamy, S, Sharanjeet-Kaur, S & Hairol, MI 2022, 'Association between Socioeconomic Status and Vision Screening Outcomes among Preschool Children in Klang Valley, Malaysia: A Cross-Sectional Study', The Malaysian Journal of Medical Sciences: MJMS, vol. 29, no. 2, pp. 102–113. doi: 10.21315/mjms2022.29.2.10.

Karuppiah, V, Wong, L, Tay, V, Ge, X & Kang, LL 2021, 'School-based programme to address childhood myopia in Singapore', Singapore Medical Journal, vol. 62, no. 2, pp. 63–68. doi: 10.11622/smedj.2019144

Latif, MZ, Hussain, I, Afzal, S, Naveed, MA, Nizami, R, Shakil, M, Akhtar, AM, Hussain, S & Gilani, SA 2022, 'Impact of Refractive Errors on the Academic Performance of High School Children of Lahore', Front. Public Health, vol. 10, p. 869294. doi: 10.3389/fpubh.2022.869294

Ma, D, Wei, S, Li, S-M, Yang, X, Cao, K, Hu, J, Peng, X, Yan, R, Fu, J, Grzybowski, A, Jin, Z-B & Wang, N 2022, 'The Impact of Study-at-Home During the COVID-19 Pandemic on Myopia Progression in Chinese Children', Frontiers in Public Health, vol. 9. doi: 10.3389/fpubh.2021.720514.

Ministry of Education Malaysia Annual Report 2021, retrieved from <https://www.moe.gov.my/storage/files/shares/Dasar/PPPM/MEB%20Annual%20Report%202021.pdf>.

Prabhu, AV, Ve, RS, Talukdar, J & Chandrasekaran, V 2019, 'Prevalence of visual impairment in school-going children among the rural and urban setups in the Udupi district of Karnataka, India: A cross-sectional study', Oman J. Ophthalmol, vol. 12, no. 3, pp. 145-149. doi: 10.4103/ojo.OJO_190_2018.

Saara, K, Swetha, S, Subhiksha, R, Amirthaa, M & Anuradha, N 2022, 'Steep increase in myopia among public school-going children in South India after COVID-19 home confinement', Indian J. Ophthalmol, vol. 70, no. 8, pp. 3040-3044. doi: 10.4103/ijo.IJO_40_22.

Saw, S, Gazzard, G, Shih-Yen, EC & Chua, WH 2005, 'Myopia and associated pathological complications', Ophthalmic & Physiological Optics: The Journal of the British College of Ophthalmic Opticians (Optometrists)', vol. 25, no. 5, pp. 381–391. doi: 10.1111/j.1475-1313.2005.00298

Wardati, HJ, Karimmah, W, Khadijah, M, Ahmad-Sharmizi, M, Wan-Julyatee, WY, Ain-Nasyrah, AS, Shahidatul-Adha, M, Waheeda-Azwa, H, Ng, KS, Jesspreet-Kaur, HS, Abdullah, NA, Hanizasurana, H & Shatriah, I 2024, 'Refractive error and amblyopia among primary school children in remote islands of East Coast of Peninsular Malaysia', The Medical Journal of Malaysia, vol. 79, no. 5, pp. 499–506, retrieved from <https://www.e-mjm.org/2024/v79n5/v79-no-5-2024.pdf>.

World Health Organization (WHO) 2019, Universal eye health: A global action plan 2014-2019, retrieved from <https://www.who.int/>.

World Health Organization (WHO) 2021, Visual impairment and blindness, World Health Organization, retrieved from <https://www.who.int/news-room/fact-sheets/detail/blindness-and-visual-impairment>.

Wu, PC, Chen, CT, Lin, KK, Sun, CC, Kuo, CN, Huang, HM, Poon, YC, Yang, ML, Chen, CY, Huang, JC, Wu, PC, Yang, IH, Yu, HJ, Fang, PC, Tsai, CL, Chiou, ST & Yang, YH 2018, 'Myopia Prevention and Outdoor Light Intensity in a School-Based Cluster Randomized Trial', Ophthalmology, vol. 125, no. 8, pp. 1239–1250. doi: 10.1016/j.ophtha.2017.12.011

Xiao, O, Morgan, IG, Ellwein, LB & He, M 2015, 'Refractive Error Study in Children Study Group, Prevalence of Amblyopia in School-Aged Children and Variations by Age, Gender, and Ethnicity in a Multi-Country Refractive Error Study', Ophthalmology, vol. 122, no. 9, pp. 1924–1931. doi: 10.1016/j.ophtha.2015.05.034.