

ORIGINAL ARTICLE

Distribution of refractive error among Chinese primary school children in a rural area in Pahang, Malaysia

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Abstract

Purpose: This study aimed to determine the prevalence and status of refractive error among Chinese primary school children in a rural area in Pahang.

Methods: This investigation entailed a cross-sectional retrospective study design involving case file analyses. The study site was a Chinese medium primary school in a rural locality within Bentong district. A total of 82 school children met the B40 classification and selection criteria; therefore, universal sampling was done. Analyses were done according to age group: Level 1 included ages 7 to 9 years, while Level 2 comprised 10- to 12-year-olds.

Results: The mean age of the 82 Chinese school children was 9.72 ± 1.5 years; the percentage of refractive errors found was 80.48%. A total of 53 (64.63%) children had myopia. Two-way ANOVA showed a significant difference ($P=0.038$) in the refractive error between age groups Level 1 and 2, but no significant difference ($P=0.947$) was observed in refractive error between genders. The chi-square test and Fisher's exact test showed no significant association between the type of refractive error with gender ($P>0.05$) and age group ($P=0.319$).

Conclusion: Myopia was the most common type of refractive error among Chinese school children in a rural area in Pahang. Refractive error severity was influenced by age group but not by gender. Types of refractive error were not associated with age group and gender. Hence, it is recommended that Chinese school children in rural areas seek an annual vision screening or eye test.

Introduction

Refractive errors are among the most common problems that individuals in developing nations in Asia currently face, representing a continuing public health problem across the world. If left untreated, visual impairments resulting from refractive errors can cause disruption of the daily activities of those afflicted,¹ especially among school-age children. Worldwide, 153 million people aged 5 years and above have been identified as visually impaired, and of these, 8 million will become blind as a result of refractive errors.² Previous studies set in Malaysia have shown that 80% of children with reduced vision have uncorrected refractive errors.³⁻⁴ In their findings, these studies also suggested that treatment of visual problems such as refractive errors must be done without delay to ensure a better prognosis.⁵⁻⁶ The types of refractive error discussed in these studies were categorised into myopia, hyperopia and astigmatism.⁷

The environment and genetics have been reported as contributing to the occurrence of

myopia and its progression.⁸ While genetic causes of myopia are more challenging to address, environmental causes can typically be effectively managed. Thus, taking a serious look at the differences in the nature and extent of refractive errors is critical, especially those that are typically closely related to places of habitation and work in both rural and urban (metropolitan) areas. Research has revealed that the prevalence of myopia and refractive error among Chinese primary school children aged between 7 and 12 years in Kuala Lumpur was 37%.⁹ The results of a similar study repeated in an urban area of the Gombak District, Kuala Lumpur, showed that Chinese school children had the highest prevalence of myopia. In contrast, hyperopia was reported to be more common among children of other races.³ Hashim et al. (2008) found that 7.7% of Malay school children aged 6 to 12 years in rural areas of Kota Bharu, Kelantan, had refractive errors.⁴ According to this study, the prevalence of myopia in rural areas was 5.4%, followed by astigmatism (1.0%) and hyperopia (0.6%). These results suggest, that a lower

prevalence of myopia was observed among Malay children who lived in rural areas in Kelantan compared to those who lived in urban areas such as Kuala Lumpur and Singapore.⁴ The findings of these studies also seem to indicate that the prevalence of myopia among Chinese primary school children is higher in urban areas when compared to Malay children; however, the prevalence rate of refractive error in these studies was only an estimated value for rural Malay school children. To the best of our knowledge, little published data are available on the prevalence of uncorrected refractive errors among primary Chinese school children in rural areas in Malaysia. Hence, evaluating the prevalence of refractive error among rural Chinese primary school children is also vital since myopia is known to be more common among the Chinese population compared to the Malays or Indians. While an ethnic difference has been noted in terms of myopia and refractive errors, the presence of a direct genetic component to this matter is unlikely, as studies involving similar ethnic populations reported in neighbouring area (Singapore) have similar findings but with varying magnitudes, leading some researchers to conclude that environmental factors probably play a larger role in this variation in magnitude.¹⁰

Thus, postulating that different lifestyles and surroundings in rural areas may have a significant impact on refractive error among children, especially those attending primary school, identifying the magnitude of this impact is essential. Since children in rural schools frequently face greater learning resource challenges compared to those in urban localities, identifying the prevalence of myopia and refractive error in both rural and urban children is vital. Furthermore, under the current Covid-19 situation, most of the teaching and learning is being conducted online, involving long hours of near work, using small display screens and engaging in longer screen viewing time. These circumstances lend even more urgency to promoting good vision in children.^{4,8,11,12} Learning resource challenges include the availability of printed learning aids, such as workbooks and study guides, and access to online resources. In the case of children in primary school, the Ministry of Education (MOE) measures their ability to complete summative and formative assessments based on their age groups. Two levels are currently employed: Level 1, which encompasses Standard 1 to 3 and involves children from age

7 to 9 years, and Level 2, which covers Standard 4 to 6 and includes children from 10 to 12 years of age. These levels reflect differences in the syllabus and learning comprehension level for the 2 age groups. In addition, the difficulty level of words that children should know and understand differs between levels.¹³ It should also be noted that primary school learning resources, especially printed books and worksheets, exhibit certain differences in the presentation of text font size and level of difficulty in terms of reading comprehension. Hence, any visual disturbances, such as blurred vision caused by refractive error, can make it difficult for affected children to cope and concentrate in class on the learning material during teaching and learning activities. Chinese school children in rural areas may share a significant prevalence of myopia with their urban peers. However, information concerning the prevalence of myopia among these rural Chinese school children is currently limited. Therefore, this study aimed to determine the prevalence and status of refractive error among Chinese primary school children in a rural area. The study was conducted at a Chinese language primary school located in Pahang. One hope for this study was to gain an indication of the prevalence of myopia and uncorrected refractive error among rural Chinese school children in order to confirm the validity of the assumption that refractive errors have a higher prevalence among urban children. Managing refractive errors in children, especially those of school-going age, is important to ensure that their learning experience is not disrupted because of blurred vision caused by uncorrected refractive error, which is an eminently avoidable reason behind visual impairment that is, for the most part, easily treated if detected early.

Methodology

This investigation entailed a cross-sectional retrospective study design involved case file analyses. The case files were obtained from the database of an Universiti Kebangsaan Malaysia, Faculty of Health Sciences, Optometry Clinic filed under the Vision Screening Community Health Programme, specifically, a programme that was carried out in a rural area in the district of Bentong, Pahang. The study site was a Chinese language primary school in a rural locality within the district of Bentong that was attended by the children living in the general vicinity of the school. The student population comprised a mixed ethnic group, with a majority of children having Chinese parents. The study was conducted among the less

privileged students as determined by the school authorities (in the B40 socioeconomic group, that is, families earning less than RM2500 per month). The study's inclusion criteria were as follows: the school child had to be of Chinese ethnicity (both parents being Chinese), had to fall within the range of 7-12 years of age, and required the permission of parents or guardians to participate. According to the study's exclusion criteria, schoolchildren of non-Chinese ethnicity or with 1 non-Chinese parent were ineligible to participate. The sample size for this study was calculated using the formula of estimating a population proportion with specified absolute precision, as described by Lwanga and Lemeshow,¹⁴ yielding a necessary sample size of 100. However, during the period of sample selection, only 82 schoolchildren in total presented and met the B40 classification and selection criteria; thus, universal sampling was done. The Universiti Kebangsaan Malaysia Ethical Committee (NN2172011) approved this study, and its conduct followed the conditions required under the Declaration of Helsinki.

Information regarding demographic data, visual

acuity, an objective and subjective refraction results were extracted from the examination records. The Snellen chart used was a series of the BS 4274-1:2003 type. Monocular visual acuity with and without correction was obtained for the right eye and left eye. The subjective refraction data was considered as the final prescription and used in the analysis. All data analyses for this study employed the Statistical Package for Social Sciences (SPSS) software version 25.0. Normality of the data was determined using the Shapiro–Wilk test. A *P* value of less than 0.05 was used to set the statistical level of significance in the analysis. Descriptive analysis was used to determine the mean, standard deviation, range, and population percentages of interest. The types of refractive errors found were reported. **Table 1** displays a summary of the myopia and hyperopia categories⁸ used. A two-way ANOVA was performed to determine the changes in refractive errors between the age groups and gender. Analyses to determine the relationship between the types of refractive error with gender and age groups included the chi-square test and Fisher's exact test.

Table 1. Category of refractive errors and the severity classification summary

Refractive errors category	Severity		
	Low	Moderate	High
Myopia	-0.25 to -3.00 Ds	-3.25 to -6.00 Ds	>-6.25 Ds
Hyperopia	+0.25 to +3.00 Ds	-3.25 to +5.00 Ds	>+5.25 Ds

Resource: AOA 1997⁸

Results

A total of 82 Chinese primary school children were enrolled in this study. The children's age range was between 7 and 12 years, and the mean age was found to be 9.72±1.5 years. The children's records were separated into 2 categories according to age, namely Level 1 (7 to 9 years) and Level 2 (10 to 12 years), as previously explained. Thirty children fell into Level 1, and the remaining 52 were in the Level 2 age group category. Out of the 82 children, 35 (42.69%) were boys, and 47 (57.31%) were girls.

Refractive Errors

The subjective refraction being prescribed to the children was used to determine refractive errors. Analysis revealed that only 62 (75.61%) of the Chinese primary school children were found to need to wear spectacles. The remaining children did not have any significant refractive errors; thus, no spectacles were prescribed for

them. Therefore, the percentage of refractive errors in the Chinese primary school children in the rural area where this study took place was calculated as 80.48%. Among the children identified as having refractive errors, 53 (64.63%) had myopia, 13 (15.86%) hyperopia, and 16 (19.51%) emmetropia. The refractive error severity level estimation was determined based on the criteria described in **Table 1**. The percentages of low, moderate, and high myopia were 79.70%, 20.75%, and 7.55%, respectively. Meanwhile, the low and high hyperopia percentages were 84.61% and 15.39%, respectively. The mean refractive error for the right eyes was -1.68±1.25 Ds, ranging from -10.00 Ds to +3.50 Ds; for the left eyes, the mean was -1.63±1.25 Ds, ranging from -9.00 Ds to +4.00 Ds. There was no significant difference (*P*=0.542) between the right and left eye refractive error. Therefore, for the subsequent analyses, only the right eye spherical equivalent data were considered and used.

Comparison of Refractive Errors between Age Groups and Genders

The mean refractive error among these Chinese primary school children for Level 1 was -0.67 ± 2.82 Ds (range -10.00 Ds to $+6.00$ Ds). For Level 2, the mean refractive error was -1.83 ± 0.18 Ds (range -9.00 Ds to $+1.50$ Ds). The mean refractive error for boys and girls was -1.69 ± 2.72 Ds and -1.20 ± 2.29 Ds, respectively. A two-way ANOVA revealed a significant difference in the refractive error between Levels 1 and 2 ($F=4.467$, $df=1$, $P=0.038$). Nevertheless, no significant difference was observed in refractive error between genders ($F=0.963$, $df=1$, $P=0.947$), as shown in [Table 2](#).

Table 2. Comparison of refractive error between age group and gender

Descriptive statistics				Test of between-subject effect			
Age group	Gender	N	Mean \pm SD	Variable	Df	F	P value
Level 1	Boys	14	-0.95 ± 2.93 DS	Age group	1	4.467	.038
	Girls	16	-0.43 ± 2.79 DS	Gender	1	.963	.330
Level 2	Boys	21	-2.19 ± 2.53 DS	Age group * Gender	1	.004	.947
	Girls	31	-1.59 ± 1.92 DS				

Association of Types of Refractive Errors with Age Group and Gender

A chi-square test showed no significant association between the type of refractive error and gender [χ^2 (1, $N=66$) = 0.645 , $P>0.05$], as can be seen in [Table 3](#). However, for the age groups, the chi-square test was not considered because more than 20% of the cells in the data table had an expected count of less than 5. Hence, Fisher's exact test was used instead for the analysis. As [Table 4](#) illustrates, the analysis showed no significant association between the type of refractive error and age group ($P=0.319$).

Table 3. Association between gender with type of refractive error

		Type of refractive error		Total	Chi-square tests for age group					
		Hyperopia	Myopia			Value	df	Asymptotic significance (2-sided)	Exact sig. (2-sided)	Exact sig. (1-sided)
Gender	Boys	7 (5.7)	22 (23.3)	29	Pearson's chi-square	.645	1	.422	-	-
	Girls	6 (7.3)	31 (29.7)	37	Continuity correction ^a	.241	1	.623	-	-
Total		13	53	66	Likelihood ratio	.641	1	.423	-	-
a. 0 cells (0.0%) have expected count < 5. The minimum expected count is 5.71.					Fisher's exact test	-	-	-	.537	.310
b. Computed only for a 2x2 table.					N of valid cases	66	-	-	-	-

Table 4. Association of age group with type refractive error

		Type of refractive error		Total	Chi-square tests for age group					
		Hyperopia	Myopia			Value	df	Asymptotic significance (2-sided)	Exact sig. (2-sided)	Exact sig. (1-sided)
Age group	Level 1	6 (4.1)	15 (16.9)	21	Pearson's chi-square	1.534 ^a	1	.216	-	-
	Level 2	7 (8.9)	38 (36.1)	45	Continuity correction ^b	.821	1	.365	-	-
Total		13	53	66	Likelihood ratio	1.467	1	.226	-	-
a. 1 cell (25.0%) had expected count < 5. The minimum expected count is 4.14.					Fisher's exact test	-	-	-	.319	.181
b. Computed only for a 2x2 table.					Linear-by-linear association	1.510	1	.219	-	-
					N of valid cases	66	-	-	-	-

Discussion

In this study, refractive errors were determined based on the final prescription of the subjective refraction prescribed to rural Chinese primary school children from the case files. A total of 75.61% of these school children were prescribed spectacles. In comparison, previous studies have identified the number of primary school children who need to wear spectacles as ranging from 17.1% to 37%.^{3,9} Thus, the present study's findings regarding the percentage of Chinese primary school children

needing spectacles was higher. A possible explanation could be attributed to differences in the study population, as the current study focused on Chinese primary school children, while previous studies investigated all ethnicities among primary school children. Moreover, we postulated that the parents or these children themselves may not have been aware that their vision was blurred and that it could be improved by wearing spectacles. It is also possible that the Chinese primary school children in this study had not attended any vision screening programme before, despite the School Health Team Vision Screening Programme by the Ministry of Health (MOH) that conducts vision screening regularly at schools.¹⁵ Notably, the MOH-sponsored School Health Team Vision Screening Programme's coverage is limited to about 10% of school populations due to certain constraints, such as scheduling issues, available teams and accessibility to the schools. The lack of awareness of the impact of uncorrected refractive errors might be considered as a major factor for the raised percentage refractive error found in this study. This lack of awareness, in combination with other factors, such as being in a rural area or of a lower socioeconomic level, as well as the availability of vision care resources, are probably complicit in the high prevalence observed regarding refractive errors needing correction. Accordingly, a comprehensive awareness programme and better visual screening coverage should be designed and implemented. Engagement with parents and the community concerning the importance of vision screening and visual error correction is an ongoing need in order to empower parents and the community to be more attentive to visual issues that can afflict their children and, furthermore, can impact their scholastic performance and achievements.

This study demonstrated the prevalence of refractive error among Chinese primary school children in a rural area to be 80.48%, which suggests that refractive error problems are not exclusive to school children in urban areas. Hence, all primary school children should undergo vision screening regardless of their locality, whether urban or rural. The refractive errors noted in this study's rural Chinese primary school children were found to be predominantly in the lower categories of either myopia or hyperopia. Similar findings have been reported among urban primary school children in Petaling Jaya.¹⁶ In the study, the children were found to have low myopia, ranging from -0.25 to -1.75 Ds in a total of 58% of the right

eye and 61.8 % of the left eye. These findings suggest that Chinese primary school children in both rural and urban areas suffer mainly low to moderate types of refractive errors, which vision screening can identify, making correction possible. Furthermore, the refractive error found, when compared between the right and left eye, did not differ significantly. This finding also suggests that less anisometropia might occur among rural Chinese primary school children.

Visual efficiency, which describes the quality of performance of the information gathering process, depends on focusing, vergence and eye movement abilities in an individual. Poor focus has a significant impact on learning and reading. The occurrence of a persistent visual problem can impact a child's visualisation skills and can affect learning ability in terms of spelling and the child's recall of spelling.¹⁷ Moreover, 80% of learning comes from visual interaction through the visual pathway.¹⁸ An earlier study showed how visual impairment could affect children's development and eventual academic performances.¹¹ As refractive error will lead to poor focusing, it is therefore necessary to highlight this issue. The percentage of myopia in this study was found to be 64.63%, a figure much higher than that found in a previous study.⁹ This finding suggests that rural Chinese primary school children experience the same problem as their peers from urban areas. Nevertheless, primary school children from rural areas face the same academic pressure as those in urban areas; moreover, competition for further education is very much contingent on the children's scholastic achievements at the end of their secondary schooling. Furthermore, under the current Covid-19 pandemic conditions, teaching and learning have mostly been conducted online, causing the learning environment to be dependent on a visual display unit such as desktop and laptop computers or even through portable devices, including mobile telephones. The different screen sizes of these devices make near tasks a challenge, typically resulting in longer viewing times.¹² This situation can cause fatigue to the visual system; moreover, previous studies have shown that excessive near tasks can accelerate the progression of myopia.^{4,8,19} Therefore, vision screening should be emphasised and conducted among all Chinese primary school children in both urban and rural areas to address and treat refractive errors as early as possible. That said, refractive errors are the only vision problem easily detected using a visual acuity test and able to be corrected easily by wearing spectacles. The

percentage of myopia is known to be higher among Chinese primary school children, and it is found in both rural and urban areas. For example, Goh et al. found that 45.3% of Chinese school-age children in Gombak had myopia compared to 13.9% Malays and 15.5% Indians from the same district.³ Thus, parents must be made aware and must be encouraged to take the initiative to bring their children for vision screening, as children may be ignorant of the fact that they have blurred vision and rarely complain of it. However there is a study reported the percentage of myopia as 5.4% among 12-year-olds, which is considerably lower than that found in this study.⁴ The difference may be due to the location of the school and the ethnic mix of the schoolchildren in the school. Regardless of the studies done, all of these investigations have reported at least or more than 10% of school children to have refractive errors; many, if not all, would benefit from treatment. Thus, eye examinations for children are essential to rule out the presence of refractive errors, many of which would require treatment, while others would need on going follow-up to manage any deterioration as the children age. Impaired vision can interfere with a child's learning process, as blurry vision can result in poor performance in school. In turn, poor performance can lead to a loss of confidence among the children, which could contribute to further deterioration in scholastic performance. In this study, the percentage of hyperopia among rural Chinese primary school children was 15.86%. This finding suggests that only a small number of Chinese primary school children had hyperopia. A previous study by Reddy et al. reported a similar finding where only a small number of hyperopia cases were identified.¹⁶ Therefore, even though the numbers are small compared to myopia, hyperopia is still a problem that can occur in Chinese primary school children. Hence, healthcare professionals should be aware of the possibility of hyperopia and should be corrected. The associated symptoms of uncorrected hyperopia are usually headache and asthenopia, and this affliction can also affect children's ability to learn.

This study showed no significant association between the types of refractive error related to age group or gender. Although there was no significant association between the types of refractive error and age group, it was noted that Level 2 (10 to 12 years) had a higher percentage of myopia (71.70 %) compared to Level 1 (7 to 9 years) children (28.30%). These findings

resemble those from a study among school-age children in Gombak. In that study, myopia was present in 9.8% of 7-year-old children, increasing to 34.4% among those 15 years old. The study concluded that myopia was associated with older age.³ Other studies that reported on the distribution pattern of refractive errors with increment in age among rural Chinese primary school children also showed a shift towards myopia with increasing age.⁹ This phenomenon was attributed to the natural physiological development of children's eyes as they grow older. The rapid growth in childhood tends to lead to myopia increments, involving changes in refractive power, corneal curvature, and axial length of the eye.²⁰ This effect can accelerate with the performance of excessive near tasks (learning activities) and through machine dependence that increases as school children grow older and progress to a higher degree of learning.^{4,21}

It was noted that gender did not seem to have any association with the types of refractive error in this study. However, myopia was found to occur in higher proportions in girls, at 58.50%, compared to boys, at 41.50%. This finding was in agreement with Goh et al.'s findings that associated myopia with the female gender.³ School children who are identified as having any refractive error should be referred to an optometry clinic for further evaluation and then received prescription according to the most appropriate management. Furthermore, refractive error needs to be treated as early as possible to minimise any adverse implications. Hence, annual vision screening programmes should be implemented for all school children to ensure that existing vision errors are detected early and any latent errors can be monitored and treated when appropriate throughout a child's school life. Parents and teachers should also be empowered via health education about the eye diseases and visual disorders that commonly occur among school children. This approach will help them detect the possible occurrence of vision problems, allowing them to seek help for investigation and treatment. For future research, it is suggested to re-evaluate and compare the prevalence of refractive error between rural and urban school children after their exposure to greater use of digital devices, as has occurred because of the ongoing Covid-19 pandemic.

Conclusion

The percentage of refractive error among rural Chinese school children was found to be 80.48%. Myopia was the most common type

of refractive error seen. The refractive error was significantly different between the Level 1 and Level 2 age groups, but no significant difference was observed between genders. There was no significant association of age group and gender with the types of refractive error, but the older age group and girls displayed a higher occurrence of myopia. As the prevalence of refractive error was found to be high among these school children, it is therefore a matter

of importance to conduct adequate vision screening in rural schools and provide a suitable annual vision screening programme for these school children.

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