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Impact of Refractive Errors on Visual Acuity and Academic Performance among Schoolchildren

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Abstract

Uncorrected refractive error can affect visual function and academic performance in schoolchildren, thus emphasising the importance of timely correction. This study examined changes in visual acuity before and after the use of glasses among 648 schoolchildren living in Kuala Lumpur. Of these, 255 schoolchildren were randomly selected for the assessment of academic performance in four main subjects, namely Bahasa Melayu, English, Mathematics, and Science, using the *Tahap Penguasaan* (TP1-TP6) levels. Myopia was the most prevalent refractive error, followed by hyperopia and astigmatism. Optimal visual correction significantly improved visual acuity and positively impacted higher TP scores.

Keywords: Refractive errors; Visual acuity; Academic performance; Vision screening

DOI:

1.0 Introduction

Refractive errors are among the most common eye problems and pose a major public health concern, especially among schoolchildren. The World Health Organization (WHO) reports that refractive errors account for a significant portion of avoidable vision loss when left uncorrected, affecting millions of children during critical periods of visual and educational development (World Health Organization, 2019). Uncorrected refractive errors can disrupt daily life and diminish quality of life (Dandona & Dandona, 2001). Childhood is crucial for visual, academic, and cognitive growth. During these formative years, children depend on their eyesight for activities like reading, writing, and participating in classes. A study suggests that up to 80% of classroom learning relies on visual information (Dudovitz et al., 2016). If refractive errors are not corrected, children may experience poorer vision and discomfort, which can affect their focus, reading abilities, and overall class participation.

Globally, the prevalence of refractive errors in schoolchildren has increased, particularly myopia (short-sightedness). It is predicted that half of the world population could be myopic by 2050 (Holden et al., 2016), and the rates of myopia have reached alarming levels, especially in East and Southeast Asia (Ding et al., 2017). Hyperopia (long-sightedness) and astigmatism (distorted vision) are also common in children and can impair vision if left untreated. In Malaysia, school-based screening programs have reported high rates of refractive errors among primary school students, underscoring the need for continuous monitoring and intervention (Wardati et al., 2024). However, the reported data remain scarce, as the mass prevalence study was conducted two decades ago in 2003 (Goh et al., 2005). While the study offered valuable insights, changes in urban lifestyles, increased digital screen use, and evolving educational requirements over the years may have significantly altered the refractive landscape for schoolchildren today. These gaps highlight the need for updated data that reflects contemporary urban educational environments.

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Beyond visual impairment, refractive errors have increasingly been acknowledged for their broader functional and educational impacts. A study indicates that children with uncorrected refractive errors tend to have poor academic performance compared to peers with good, optimal vision (Pirindhavellie et al., 2023). An intervention study using a randomized controlled trial showed that providing glasses led to significant improvements in academic performance, hence supporting the connection between correcting vision and improved educational outcomes (Ma et al., 2014). Therefore, this study aimed to evaluate the trends in refractive errors and their effects on vision improvement before and after receiving spectacle correction among schoolchildren in Kuala Lumpur. The study also sought to investigate the changes in academic performance across four key subjects. By merging clinical and educational findings, this study aims to inform evidence-based screening practices and improve early intervention in school environments.

2.0 Literature Review

2.1 Prevalence and Clinical Impact of Refractive Errors

The prevalence of refractive error varies between countries and ethnic groups residing in different geographic locations. For instance, a study conducted among Chinese preschool children in Changsha reported astigmatism as the most prevalent refractive error (17.6%), followed by hyperopia (13.8%) and myopia (2.94%), with with-the-rule (WTR) astigmatism being the predominant axis orientation (You et al., 2022). In contrast, a Malaysian study conducted in Wangsa Maju found myopia as the most common refractive error (30.2%), followed by astigmatism (16.3%) and hyperopia (1.2%) (Ismail & Sukumaran, 2022). Such differences may reflect genetic predisposition, urban educational demands, and environmental exposures such as near-work exposure and reduced outdoor activity (Morgan et al., 2018).

Beyond the prevalence patterns, the clinical consequences of uncorrected refractive errors are functionally significant. Schoolchildren are often unaware of their visual problems and may not report any symptoms. Instead, they may compensate by altering their seating position or avoiding visually demanding tasks. Such adaptive behaviours may negatively influence academic development. Given the evolving lifestyle patterns and the limited availability of contemporary Malaysian data (Goh et al., 2005), an updated epidemiological assessment is warranted to evaluate their functional impact on visual acuity and academic performance.

2.2 Impact of Visual Acuity on Academic Performance

Vision is important for early educational development, especially during primary school years when students build basic literacy and math skills. Poor vision affects reading speed, comprehension, and academic confidence among children, making it difficult to read books or see the board clearly. This visual impairment can lead to more mistakes and lower academic achievement (Loh et al., 2024). A study in Singapore found that uncorrected refractive error was common and could negatively impact classroom performance, highlighting the educational effects of vision problems (Dirani et al., 2010).

There is a link between academic success and visual acuity. A randomized controlled trial on rural Chinese schoolchildren showed that those who received glasses scored a significant improvement in academic outcomes. The study reported that the intervention was effective on Mathematics test scores compared to their peer in the control group who did not receive any intervention (Ma et al., 2014). The results indicate that improved vision helps students to access learning materials and classroom instruction, thereby improving academic performance. However, the extent of academic improvement may depend on the severity of the initial visual impairment, the type of refractive error, and other factors such as the classroom environment and economic background.

3.0 Methodology

The present study employed a quantitative retrospective observational study design. The aim of the study is to investigate the impact of refractive errors on visual acuity and academic performance among schoolchildren. The study was conducted using data from school vision screening programs carried out in randomly selected public primary schools in Kuala Lumpur, Malaysia. The target population consisted of primary schoolchildren aged 7 to 9 years who attended the vision screening programmes. Schoolchildren within this age were identified from screening records and had complete documentation of visual acuity measurements, before and after receiving spectacle correction. Of these, a sample of the schoolchildren was randomly selected (approximately 40%) for the evaluation of academic performance outcomes. Inclusion criteria included school-aged children diagnosed with refractive errors during the screening programme, with complete records of pre- and post-correction visual acuity. For the analysis of academic performance, only children with complete data of *Tahap Penguasaan* (TP) records for four core subjects, namely Bahasa Melayu, English, Mathematics, and Science during pre- and post-spectacle correction, were included. Children with incomplete visual or academic records were excluded from the study.

Visual acuity was measured before and after spectacle correction using a standardized digital visual acuity chart (Canton Optics Equipment Co. Ltd., China). Measurements were recorded monocularly (each eye) and binocularly (both eyes). Habitual visual acuity findings were recorded in Snellen notation and were then converted to the two-decimal logarithm of the minimum angle of resolution (LogMAR) units. Refractive errors were categorized into myopia, hyperopia, and astigmatism based on clinical refraction findings obtained during the screening programme. In cases where accommodative control was deemed unstable in subjective responses, a modified cycloplegic refraction using the delayed fogging technique (plus lenses) was applied to minimise accommodative influence. Improvement in visual acuity was determined by comparing the pre- and post-correction of visual acuity measurements.

Academic performance was assessed using *Tahap Penguasaan* (TP) levels in accordance with the standard rubrics established by Kementerian Pendidikan Malaysia (KPM). TP levels range from TP1 to TP6, with higher levels indicating increasing academic

performance. Baseline TP levels were obtained from school records during mid-school term, prior to spectacle correction. The follow-up TP results were collected at the end of the year term after receiving the spectacle correction. Academic performance was evaluated across four core subjects: Bahasa Melayu, English, Mathematics, and Science. Changes in TP levels before and after spectacle correction were examined to determine whether improvements in academic performance have an impact on changes in TP levels.

Data was analyzed using the IBM Statistical Package for the Social Sciences (SPSS) version 29.0. Descriptive statistics were used to summarize demographic characteristics and the distribution of refractive error types. The trend of myopia, hyperopia, and astigmatism was calculated. A paired-samples t-test was used to examine differences in visual acuity before and after spectacle correction. Changes in academic performance (TP levels) were analyzed descriptively to assess shifts from lower mastery levels (TP1–TP3) to higher mastery levels (TP4–TP6). A p-value of less than 0.05 was considered statistically significant.

Ethical approval for this study was obtained from the Research Ethics Committee of Universiti Teknologi MARA (REC/12/2025 [ST/MR/224]). All procedures were conducted in accordance with the Malaysian Good Clinical Practice Guidelines and the Declaration of Helsinki.

4.0 Findings

4.1 Demographic Characteristics

A total of 648 primary schoolchildren aged 7 to 9 years were included in this study. The demographic characteristics of the participants are presented in Table 4.1. Of the total sample, 340 (52.5%) were male, and 308 (47.5%) were female, indicating a slightly higher proportion of male participants. Regarding age distribution, the majority of participants were 7 years old (n = 268, 41.4%), followed by 8-year-olds (n = 198, 30.6%) and 9-year-olds (n = 182, 28.1%). This shows that the study sample was predominantly composed of younger primary schoolchildren.

Table 4.1 Demographic Characteristics of Participants

Demographic Variable		Frequency (n)	Percentage %
Gender	Male	340	52.5
	Female	308	47.5
Age	7-year-old	268	41.4
	8-year-old	198	30.6
	9-year-old	182	28.1

4.2 Distribution of Refractive Errors

The overall distribution of refractive errors is presented in Table 4.2. Myopia was the most prevalent type of refractive error (n=415, 64.0%), followed by hyperopia (n=185, 28.5%) and astigmatism (n=48, 7.4%). No missing data were recorded for the final refractive error classification.

Table 4.2. Distribution of Refractive Errors Among Participants

Refractive Error	Frequency (n)	Percentage %
Myopia	415	64.0
Hyperopia	185	28.5
Astigmatism	48	7.4
Total	**648**	**100.0**

4.3 Changes in Visual Acuity Before and After Spectacle Correction

Paired-samples t-tests were conducted to examine differences in visual acuity measured in logMAR units before (unaided) and after (aided) spectacle correction across refractive error groups. The logMAR notation indicates that the smaller the logMAR value, the better the visual acuity. Among the participants with myopia (n = 415), visual acuity significantly improved following spectacle correction. In the right eye, the mean±standard deviation of unaided logMAR visual acuity improved from 0.40±0.27 to 0.10±0.13 after spectacle correction, $t(414) = 22.97$, $p < .001$. A similar improvement was also noted in the logMAR visual acuity of the left eye from 0.38±0.26 to 0.10±0.12, $t(414) = 22.46$, $p < .001$. For the hyperopia group (n = 185), the mean±standard deviation of unaided logMAR visual acuity improved from 0.33±0.23 to aided logMAR visual acuity 0.09±0.13, $t(184) = 15.79$, $p < .001$. Again, a similar trend was also noted for the left eye, from 0.33±0.22 to 0.10±0.15), $t(184) = 15.91$, $p < .001$. Similarly, in children with astigmatism (n = 48), the mean±standarad deviation of the right eye improved from 0.39±0.22 to 0.13±0.13, $t(47) = 7.99$, $p < .001$. In the left eye, logMAR visual acuity improved from 0.34±0.24 to 0.13±0.13, $t(47) = 6.57$, $p < .001$. Overall, spectacle correction significantly improved visual acuity across all refractive error groups in both eyes.

Table 4.3. Comparison of Unaided and Aided Visual Acuity (logMAR) Before and After Spectacle Correction by Refractive Error

Refractive Error	Right Eye				Left Eye			
	Before Mean ± SD	After Mean ± SD	t (df)	p	Before Mean ± SD	After Mean ± SD	t (df)	p
Myopia (n=415)	0.40 ± 0.27	0.10 ± 0.13	22.97 (414)	<.001	0.38 ± 0.26	0.10 ± 0.12	22.46 (414)	<.001
Hyperopia (n=185)	0.33 ± 0.23	0.09 ± 0.13	15.79 (184)	<.001	0.33 ± 0.22	0.10 ± 0.15	15.91 (184)	<.001
Astigmatism (n=48)	0.39 ± 0.22	0.13 ± 0.13	7.99 (47)	<.001	0.34 ± 0.24	0.13 ± 0.13	6.57 (47)	<.001

4.4 Changes in Academic Performance (Tahap Penguasaan Levels)

Changes in academic performance before and after receiving spectacle correction were evaluated using Tahap Penguasaan (TP) levels across four core subjects: Bahasa Melayu, English, Mathematics, and Science (n = 255). For Bahasa Melayu, most students scored TP3 (40.0%) before receiving spectacle correction, followed by TP2 (25.9%) and TP4 (20.8%). After receiving spectacle correction, some children scored TP levels. The proportion of students achieving TP5 increased from 4.3% to 9.1%, and TP6, which was absent initially, emerged at 1.9%. Concurrently, lower TP levels (TP1 and TP2) showed a marked reduction. For English, most students initially scored TP2 (31.8%) and TP3 (32.5%) prior to spectacle correction. Following post-spectacle correction, the percentage of students achieving TP4 dropped from 20.0% to 12.3%, accompanied by the increase of TP5 from 2.7% to 4.8%. TP6 which was initially absent appeared at 1.1%. A decrease in the proportion of students at lower TP levels was observed. For Mathematics, the score was predominantly concentrated at TP3 (19.0%). After receiving spectacle correction, improvements were evident in higher TP levels, with TP4 increased from 8.3% to 13.1%, TP5 from 2.8% to 8.2%, and TP6 emerging at 2.3%. Lower TP levels demonstrated a relative decline in trend. Similarly, in Science, most students were initially at TP3 (24.8%) prior to spectacle correction. Post-spectacle correction resulted in an increase of TP4 (from 8.5% to 16.7%) and TP5 (from 2.5% to 11.0%), with TP6 emerging at 1.2%. Overall, across all four subjects, an upward shift in the academic TP levels was evident following spectacle correction, with higher TP categories (TP4–TP6) was increasing and lower categories (TP1–TP3) was decreasing.

Table 4.4 Changes in *Tahap Penguasaan* (TP) Levels Before and After Spectacle Correction (n = 255)

Subject	TP Level	Before n (%)	After n (%)
Bahasa Melayu	**TP1**	23 (9.0)	1 (0.2)
	TP2	66 (25.9)	29 (4.5)
	TP3	102 (40.0)	87 (13.4)
	TP4	53 (20.8)	67 (10.3)
	TP5	11 (4.3)	59 (9.1)
	TP6	0 (0.0)	12 (1.9)
English	**TP1**	33 (12.9)	6 (0.9)
	TP2	81 (31.8)	47 (7.3)
	TP3	83 (32.5)	83 (12.8)
	TP4	51 (20.0)	80 (12.3)
	TP5	7 (2.7)	31 (4.8)
	TP6	0 (0.0)	7 (1.1)
Mathematics	**TP1**	16 (2.5)	2 (0.3)
	TP2	44 (6.8)	29 (4.5)
	TP3	123 (19.0)	71 (11.0)
	TP4	54 (8.3)	85 (13.1)
	TP5	18 (2.8)	53 (8.2)
	TP6	0 (0.0)	15 (2.3)
Science	**TP1**	22 (3.4)	14 (2.2)
	TP2	161 (24.8)	54 (8.3)
	TP3	55 (8.5)	108 (16.7)
	TP4	11.70 (1.38)	11.05 (1.31)
	TP5	16 (2.5)	71 (11.0)
	TP6	0 (0.0)	8 (1.2)

5.0 Discussion

The findings of this study showed that myopia was the most common type of refractive error among primary schoolchildren. Wearing glasses significantly improved visual acuity in all groups with refractive errors. This was supported by an increase in the academic performance of TP levels after students received glasses. The rate of myopia in this group was higher than earlier data from Malaysian

studies. The National Eye Survey from 1996 found a relatively low prevalence of myopia in Malaysia (Zainal et al., 2002). However, research over the last twenty years shows a steady increase, which coincides with rapid urbanization, greater academic demands, and lifestyle changes that include more screen time and less outdoor activity. Earlier regional studies hinted at this trend. One study showed high rates of refractive errors among Chinese schoolchildren in urban Kuala Lumpur, suggesting that living in the city may increase the risk of myopia (Chung et al., 1996). More recently, 47.8% of schoolchildren in Kuala Lumpur were found to have refractive errors, highlighting a significant rise in urban prevalence (Ismail & Sukumaran, 2022). The current study reports a rate of 64.0%, which is higher than those noted in earlier Malaysian research, including the latest urban data. This may indicate a growing issue of myopia among younger primary schoolchildren, likely due to more exposure to early education, increased use of digital devices, and lifestyle changes in urban areas.

Significant improvement in visual acuity was observed across all refractive error groups in both eyes following spectacle correction, resulting in clinically meaningful visual improvement. The magnitude of improvement was particularly pronounced in the myopia group, which accounts for the largest sample size. Similar improvements were seen in those with hyperopia and astigmatism, showing that any type of refractive correction effectively improves visual clarity. These results support earlier findings indicating that providing glasses greatly enhances visual acuity in schoolchildren with uncorrected refractive errors. A population-based study in Gombak reported significant gains in visual acuity after receiving proper correction, with many more children achieving normal or near-normal vision in at least one eye. This study noted about a 40.9% reduction in bilateral visual impairment compared to those without correction (Goh et al., 2005). A Similar report was observed by (Ma et al., 2014) in a study of Chinese schoolchildren, which confirmed that fixing refractive errors leads to measurable improvements in visual performance in educational settings.

In addition to improvements in visual acuity, the study showed an increase in academic performance levels in all four core subjects after the children received glasses. Prior to the correction, the majority of the students were at lower TP levels (TP1–TP3). Following the spectacle correction, there was a rise in higher TP levels (TP4–TP6), with TP6, which was initially absent. This suggests that better visual clarity may improve engagement in the classroom and learning outcomes. Thus, correcting refractive errors could remove visual barriers to learning. A well-designed randomized controlled trial in rural Gansu province in China found that giving myopic students glasses improved their standardized Mathematics scores (Du et al., 2022). A study in Baltimore showed that students who received glasses had higher reading scores after one year (Dudovitz et al., 2020). Together, these findings suggest that correcting refractive errors may enhance performance not only in numerically demanding subjects such as Mathematics but also in subjects requiring detailed visual discrimination, ultimately contributing to overall academic improvement.

The results of this study underscore the need for regular school-based vision screenings and the quick provision of glasses. Early detection and treatment of refractive errors in primary schoolchildren can improve visual health and support academic growth. Given that myopia is common in this group, preventive measures may be beneficial.

Retrospective design without a control group limits causal inference. The study was conducted within a specific geographical region, which may limit generalizability to other populations. Future research employing longitudinal or controlled designs would provide stronger evidence regarding the direct impact of refractive correction on academic performance.

6.0 Conclusion& Recommendations

In conclusion, myopia was the most common refractive error among primary schoolchildren in Kuala Lumpur. Using glasses to achieve optimum visual performance led to significant improvements in visual acuity for all refractive error groups. It also coincided with better academic performance. These findings show how important it is to detect and correct refractive errors early to support both vision and education in young children. Early and regular vision screening in schools should be improved to ensure that refractive errors are detected and corrected on time. The high rates of myopia and the improvements in visual clarity and academic performance after getting glasses highlight the need for collaboration among healthcare providers, schools, and parents. Future long-term studies using consistent academic measures are recommended to establish cause-and-effect relationships.

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Paper Contribution to Related Field of Study

This study contributes to existing literature by providing updated evidence on the prevalence of refractive errors among primary schoolchildren in Kuala Lumpur, revealing a high rate of myopia in this young cohort. It further demonstrates significant improvements in visual acuity following spectacle correction and highlights an associated upward shift in academic performance levels (TP). By linking

visual health with educational outcomes, this study underscores the importance of early detection and timely correction of refractive errors, supporting the integration of school-based vision screening programmes into public health and educational strategies.

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