Original Article

Prevalence of refractive errors among school children in Wangsa Maju, Kuala Lumpur, Malaysia

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ABSTRACT

Background: Uncorrected refractive error is the most common cause of vision impairment and the second leading cause of blindness worldwide. Its prevalence differs among and within countries. This study was aimed at exploring the pattern and prevalence of refractive error among school children in the Wangsa Maju Township, Kuala Lumpur, Malaysia.

Methods: A stratified, multistage, cluster random sampling in a geographically defined area was employed, and 245 school children, aged 8 – 12 years, from two primary schools in Wangsa Maju Township, Kuala Lumpur, were recruited. The cross-sectional study employed interviewing, measuring uncorrected distance visual acuity (UCDVA) using the Snellen chart, cycloplegic refraction under a streak retinoscope refined subjectively, and a detailed slit-lamp examination to assess the anterior and posterior segments. Myopia, hyperopia, and astigmatism were defined as spherical equivalent (SE) ≥ - 0.50, SE ≥ + 2.00, and cylindrical ≥ 0.75 D, respectively. Reduced UCDVA was defined as an unaided visual acuity < 6/9.

Results: The mean (standard deviation) age of the participants was 10.42 (1.22) years. The overall prevalence of refractive error was 47.8%. Of 245 screened school children, including 42 (35.9%) boys and 75 (64.1%) girls, 117 had refractive error, with a prevalence of refractive error of 17.1% and 30.6% in boys and girls, respectively. Myopia was the most common type (30.2%), followed by astigmatism (16.3%) and hyperopia (1.2%). The prevalence of reduced UCDVA was 36.3% among the screened school children, attributable to refractive error with a significantly high positive correlation (r = +.721; $P < 0.01$). Among those with refractive errors, sex differences in the magnitude of refractive errors were not statistically significant in the three types of refractive errors (all $P > 0.05$).

Conclusions: The prevalence of refractive error among primary school children in Wangsa Maju Township, Kuala Lumpur, Malaysia was 47.8%; girls outnumbered boys, but the magnitude of refractive errors showed no sex differences. The prevalence of reduced UCDVA was 36.3%, attributable to refractive error. Irrespective of sex, myopia had the highest prevalence compared to other refractive errors, and its prevalence increased with age. Future population-based studies are required to address the limitations concerning environmental risk factors for refractive error and the impact of ethnic or familial backgrounds on their prevalence in a similar but larger population using the same protocol.

KEYWORDS

prevalences, refractive error, myopias, vision screenings, school children, Malaya

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INTRODUCTION

Refractive errors are the most common vision problem that occur when the shape of the eye prevents correct focusing and results in blurred vision [1, 2]. Uncorrected refractive error is the most common cause of vision impairment and the second leading cause of blindness globally [3].

The prevalence of refractive errors differs among and within countries and even among people with the same ethnic background. The prevalence of myopia, hyperopia, and astigmatism among Chinese preschool children in Changsha is 2.94%, 13.8%, and 17.6%, respectively [4]. The prevalence of myopia and anisometropia in Dalian, northeast China, differs significantly between urban (82.71 and 7.27%, respectively) and rural (71.76% and 5.41%, respectively) students because of differences in sociodemographic and physiologic factors [5]. The prevalence of myopia in 6 – 7-year-old Chinese children from Sydney is significantly lower compared to those from Singapore (3.3% versus 29.1%) [6].

In Saudi Arabia, the prevalence of uncorrected refractive errors among school children is 50.91% [7]. In Hungary, the prevalence of myopia, hyperopia, and emmetropia is 43.45%, 16.50%, and 40.05%, respectively [8]. In Kazakhstan, the overall prevalence of refractive errors, myopia, hyperopia, and astigmatism among school children is 31.6%, 28.3%, 3.4%, and 2.8%, respectively [9]. In Iran, the age-adjusted prevalence of refractive error is 16.32% [10]. In Portugal, it is 31.9%, with a significant refractive error in 20% of children and 50% of adults [11].

Population-based studies have yielded critical data regarding the frequency and impact of major ocular diseases in the community. Continual surveys over time may also demonstrate the impact of preventive strategies [12]. A study on the estimated prevalence of visual impairment due to uncorrected refractive error using published and unpublished surveys estimated 153 million people aged ≥ 5 years to be visually impaired globally, 8 million of whom were blind [13]. Approximately 12.8 million people with ages ranging from 5 to 15 years are visually impaired because of uncorrected refractive errors, with a global prevalence of 0.96%. The highest prevalence is in highly developed urban regions of Southeast Asia in China [13].

Studies on the role of sex [14] have reported inconsistent results. Some studies reported a higher prevalence in girls than in boys [15-17]. Moreover, refractive error is rising in all populations, and vision screening for early detection of refractive error, particularly during a critical period of visual development, may be helpful [18, 19]. The reason for managing refractive errors in childhood is the likelihood of developing amblyopia when left untreated [20].

To our knowledge, no study has investigated the pattern or prevalence of refractive errors among 8- to 12-year-old school children in Wangsa Maju Township, Kuala Lumpur, Malaysia. The present study was aimed at investigating the pattern and prevalence of refractive error among 8 – 12-year-old school children in Wangsa Maju Township, Kuala Lumpur, Malaysia.

METHODS

In this cross-sectional study, a multistage cluster random sampling method was used [21]. We defined six primary schools in the Wangsa Maju Township, and two primary schools were randomly selected: Sekolah Kebangsaan Wangsa Maju Zon R10 and Sekolah Kebangsaan Wangsa Melawati. The study protocol was approved by the Ethics Committee of the Faculty of Medicine and Health Sciences, University College Sedaya International University on April 14, 2017 (approval number: IEC-2017-FMHS-031). Informed consent was obtained from parents or legal guardians before commencement of the study.

The study was conducted from May 2017 to May 2018. Five optometrists who are lecturers at the School of Optometry were involved as examiners. Before the commencement of the study, all examiners were trained on the study protocol and standard operating procedures to ensure consistency in data collection.

The inclusion criteria were literate Malaysian school children aged 8 – 12 years who could understand instructions during the visual acuity measurement and interview sessions. School children with ocular disease, a history of ocular trauma related to visual dysfunction, learning difficulties, or inability to cooperate were excluded.

The uncorrected distance visual acuity (UCDVA) of school children was recorded using the Snellen chart (auto chart projector FR-1003 LED, Frey, Warsaw, Poland). Autorefraction (Potec PRK-6000 Autorefractometer, Potec Ltd., South Korea) was performed, followed by cycloplegic refraction 10 min after 1% cyclopentolate hydrochloride (Cyclogyl 1%, Alcon Laboratories Inc., Fort Worth, TX, USA) eye drop instillation in the conjunctival sac twice, 5 min apart, under a streak retinoscope (Welch Allyn Retinoscope, Welch Allyn Inc., NY, USA). Subsequently, subjective refinement was performed. All children underwent a detailed slit-lamp examination (SL-D701; Topcon, Tokyo, Japan) to assess the anterior and posterior segments.

Myopia or hyperopia was determined by the spherical equivalent (SE) of cycloplegic refraction, i.e., a sphere plus half cylinder. Myopia, hyperopia, and astigmatism were defined as SE ≥ - 0.50, SE ≥ + 2.00, and cylindrical ≥ 0.75 D [17]. Reduced UCDVA was defined as an unaided distance visual acuity of < 6/9 using the Snellen chart.

Data were collected, and IBM SPSS Statistics for Windows (version 25.0; IBM Corp., Armonk, NY, USA) was used for statistical analyses. The normality of data distribution was evaluated using the Shapiro – Wilk test. Descriptive statistics was used to analyze the demographic data and the prevalence of refractive error. Data are expressed as mean, standard deviation (SD), median, frequency, and percentage. The Mann – Whitney U test was used to compare the magnitude of each type of refractive error between the sexes. The correlation between reduced UCDVA and refractive error was checked using Spearman's rank-order correlation test. Statistical significance was set at a *P*-value < 0.05.

RESULTS

Of all screened children, four were excluded: two because of ocular disease attributed to ocular trauma referred to the Eye Clinic in Hospital Universiti Kebangsaan Malaysia, Cheras, Kuala Lumpur, and two because of uncooperativeness. Finally, 245 school children with age of 8 – 12 years were recruited who had a mean (SD) age of 10.42 (1.22) years. The overall prevalence of refractive errors was 47.8%. Table 1 shows the demographic data of the school children with and without refractive errors.

Table 2 shows the distribution of reduced UCDVA among different age groups in school children with or without refractive error, indicating the highest and lowest prevalence in children aged 8 (60.0%) and 10 (30.8%) years, respectively. The overall prevalence of reduced UCDVA was 36.3%, with the highest prevalence (71.8%) among those with refractive error (84 of 117), and 3.9% (five of 128) in those without refractive error.

Refractive error and reduced UCDVA showed a strong positive correlation (r = +.721; *P* < 0.001) (Table 3). This indicates that the reduced UCDVA was attributable to refractive error.

Table 4 shows the distribution of the refractive status of the screened school children overall and at each age. Among those with refractive errors, the prevalence of myopia, astigmatism, and hyperopia were 30.2%, 16.3%,

Table 1. Demographic data of 245 screened school children with and without refractive error

Characteristic	School children with refractive error, n (%)	School children without refractive error, n (%)	Total, n (%)
Age (y)			
8	7 (2.9)	3 (1.2)	10 (4.1)
9	33 (13.5)	40 (16.3)	73 (29.8)
10	4 (1.6)	9 (3.7)	13 (5.3)
11	43 (17.6)	58 (23.7)	101 (41.2)
12	30 (12.2)	18 (7.3)	48 (19.6)
Total	117 (47.8)	128 (52.2)	245 (100)
Sex			
Male	42 (17.1)	59 (24.1)	101 (41.2)
Female	75 (30.6)	69 (28.2)	144 (58.8)
Total	117 (47.8)	128 (52.2)	245 (100)

Abbreviations: n, number of school children, %, percentage; y, years.

Table 2. Distribution of reduced UCDVA among 245 screened school children with and without refractive error

Age (y)	School children with reduced UCDVA (n)		Total (n)
	With refractive error	Without refractive error	
8	6	0	10
9	24	1	73
10	4	0	13
11	31	2	101
12	19	2	48
Total	84	5	245

Abbreviations: reduced UCDVA, uncorrected distance visual acuity of less than 6/9 using the Snellen chart (auto chart projector FR-1003 LED, Frey, Warsaw, Poland); y, years; n, number; Total, total number of school children with or without reduced UCDVA.

Table 3. Correlation between reduced UCDVA and presence of refractive error in 245 screened school children

Variable	Reduced UCDVA		Correlation Coefficient	*P*-value*
	Yes, n (%)	No, n (%)		
Without refractive error	5 (2.0)	123 (50.2)	+ 0.721	**< 0.001**
With refractive error	84 (34.3)	33 (13.5)		

Abbreviations: reduced UCDVA, uncorrected distance visual acuity of less than 6/9 using the Snellen chart (auto chart projector FR-1003 LED, Frey, Warsaw, Poland); n, number of school children; %, percentage. *P* < 0.05 is shown in bold.

Table 4. Distribution of the type of refractive error among age groups of 245 screened school children

Age (y)	Refractive status, n (%)				Total, n (%)
	Emmetropia	Myopia (SE ≥ - 0.50 D)	Hyperopia (SE ≥ + 2.0 D)	Astigmatism (Cylindrical ≥ 0.75 DC)	
8	3 (1.2)	1 (0.4)	0 (0.0)	6 (2.5)	10 (4.1)
9	40 (16.3)	14 (5.7)	2 (0.8)	17 (6.9)	73 (29.8)
10	9 (3.7)	1 (0.4)	0 (0.0)	3 (1.2)	13 (5.3)
11	58 (23.7)	33 (13.5)	1 (0.4)	9 (3.7)	101 (41.2)
12	18 (7.3)	25 (10.2)	0 (0.0)	5 (2.0)	48 (19.6)
Total	128 (52.2)	74 (30.2)	3 (1.2)	40 (16.3)	245 (100.0)

Abbreviations: n, number of school children; %, percentage; y, years; SE, spherical equivalent; D, diopters; DC, diopters cylinder.

Table 5. Sex difference in the magnitude of refractive errors among 117 screened school children with refractive error

Type of refractive error	Boys	Girls	*P*-value
Myopia (D), Mean ± SD, Median	- 2.00 ± 2.37, - 1.75	- 1.55 ± 2.62, - 1.50	0.694
Hyperopia (D), Mean ± SD, Median	+ 1.75 ± 2.25, + 2.00	+ 0.50 ± 1.50, + 0.38	1.000
Astigmatism (DC), Mean ± SD, Median	- 1.50 ± 2.50, - 1.25	- 1.25 ± 2.71, - 1.38	0.508

Abbreviations: D, dioptre; SD, standard deviations; DC, diopters cylinder.

and 1.2% overall, respectively; 9.4%, 7.4%, and 0.4% among boys, respectively; and 20.8%, 9.0%, and 0.8% among girls, respectively. Of the 245 screened school children, including 42 (35.9%) boys and 75 (64.1%) girls, 117 had refractive error, with prevalence of refractive error of 17.1% and 30.6% among boys and girls, respectively.

Table 5 shows sex differences in the magnitude of the three types of refractive errors. The mean (SD) refractive error did not differ significantly between the sexes (all $P > 0.05$).

DISCUSSION

The prevalence of refractive error among the 245 screened school children was 47.8%, with higher prevalence in older children and in girls than in boys. The prevalence of reduced UCDVA was 36.3%, attributable to refractive error with a strong positive correlation. However, the magnitude of the three types of refractive error showed no sex differences among the 117 school children with refractive errors. Irrespective of sex, myopia had the highest prevalence, which increased with age.

Uncorrected refractive error was the leading cause of low vision (3/60 ≤ visual acuity < 6/18 in the better eye with the available means of correction) in a previous population-based study involving the Malaysian population [22], accounting for approximately half of the cases, with a significantly higher prevalence in females and 4.10% of cases of blindness (visual acuity worse than 3/60 or inability to count fingers at 3-m distance). The prevalence of visual impairment (visual acuity worse than 6/18 in the better-seeing eye with the available means of correction) attributable to uncorrected refractive errors revealed two peaks by age: young adults and people older than 50 years [22]. In the present study, refractive errors had a prevalence of 47.8% among Malaysian school children, and reduced UCDVA and refractive error correlated significantly.

Goh et al. [17], in a population-based study involving 4634 7– 15-year-old school children from 3004 households in the Gombak District, a suburban area near Kuala Lumpur, revealed that refractive error was the leading cause of reduced vision (UCDVA worse than 20/32), accounting for 87.0% of the screened school children. Myopia (SE ≥ - 0.5 D in either eye) was detected in 9.8% of 7-year-old children and 34.4% of 15-year-

old children. It was associated with older age and female sex. The prevalence of hyperopia (SE ≥ + 2.00 D) was 3.8% – 5% in 7-year-old children and < 1% in 15-year-old children. It was associated with younger age. Astigmatism (cylindrical ≥ 0.75 DC) was detected in 15.7% and 21.3% of school children using retinoscopy and autorefraction, respectively [17]. We found a prevalence of 36.3% for a UCDVA worse than 20/30, significantly correlated with refractive error. Using a similar definition of refractive error, we detected myopia in 52.2% of all screened school children. It was 0.4% in 8-, 13.5% in 11-, and 10.2% in 12-year-old children. Hyperopia was detected in 1.2% of all screened school children and ranged from 0.0% to 0.8% across all age groups. Astigmatism was detected in 16.3% of school children, with the highest prevalence in 9-year-old children, but did not increase with age.

Hashim et al. [23] conducted a school-based cross-sectional study involving 705 6 – 12-year-old school children of Malay ethnicity in the suburban area of Kota Bharu, Kelantan, Malaysia, and found a prevalence of 7.7% for uncorrected visual impairment. Refractive error was the leading cause of reduced vision (UCDVA of 20/40 or worse), accounting for 90.7% of cases, with a prevalence of 7.0% among the study population. Among those with refractive errors, the prevalence of myopia, hyperopia, and astigmatism was 5.4%, 1.0%, and 0.6%, respectively, and the prevalence of myopia (53.1%) and hyperopia (12.3%) among girls outnumbered that of myopia (24.5%) and hyperopia (2.0%) among boys. Myopia development has a significant positive correlation with increasing age, more hours spent reading books, positive history of siblings wearing glasses, and higher educational level of parents [23]. Considering the 47.8% overall prevalence of refractive error (17.1% in boys and 30.6% in girls), our screened population had a considerably higher prevalence. This difference verifies the findings of previous studies, which reported different prevalence rates within countries and even among people of the same ethnic background [4-6]. Furthermore, it indicates the importance of vision screening programs among various communities or areas in the same country to discover the actual magnitude of this avoidable and prevalent cause of visual impairment [3]. The authors believe that providing real data is a wise tactic to guide resource allocation decisions for healthcare decision makers with a practical approach within the country.

Bakar et al. [24], in a cross-sectional study involving 293 Native Iban and Malay school children, reported prevalence of 47.7% and 3.5% for refractive error and visual impairment (visual acuity of 6/12 or worse), respectively. Among students with refractive errors, myopia (SE ≥ - 0.5 D) accounted for 97.1% of cases and was significantly more common in girls than in boys, and 94.1% of school children with refractive error had the wrong prescription (7.8%) or uncorrected refractive errors (92.2%). The proportion of students with myopia has increased with increasing levels of education [24]. In the present study, the prevalence rate for refractive error is similar to that reported by Baker et al., but visual impairment, which was defined as a UCDVA of 6/9 in the present study, was 36.3% and ten times higher. This may be partly justified by the difference in the reduced UCDVA cut-off between the two studies. Using the same definition, myopia accounted for 63.2% of students with refractive errors in the present study, which is significantly less than that in the screened population. This indicates the difference in the prevalence rate of the type of refractive error within countries and even among people of the same ethnic background [4-6].

In previous studies on refractive error, sex, age, family inheritance, and environmental factors were major factors in the progression of refractive error in children [25-28]. The prevalence of myopia increased with age: 0.4% in 8-, 13.5% in 11-, and 10.2% in 12-year-old children. However, the prevalence of hyperopia and astigmatism remained almost the same. The prevalence of refractive error differs significantly between boys and girls of different ethnicities. In a cross-sectional study involving 168 10 – 12-year-old Chinese school children in Malaysia by Jayaraman et al., refractive error was higher among girls (73.6%) than among boys (58.4%) [33]. Other studies revealed a significant difference in the presence of refractive errors between the two sexes among school children [15-17]. In contrast, several studies revealed no significant difference in the prevalence of refractive error between boys and girls [29-32]. In this study, girls (75 [64.1%]) with refractive error outnumbered boys (42 [35.9%]), and the prevalence of refractive error was higher in girls (30.6%) than in boys (17.1%); however, the magnitude of the three types of refractive error did not differ significantly between the sexes.

To our knowledge, this is the first study to report the pattern of refractive error and its prevalence among 8 – 12-year-old school children in Wangsa Maju Township, Kuala Lumpur, Malaysia. The prevalence rate is considerable; therefore, we believe that government and optometry associations should work together to conduct annual vision screening and eye health programs in government primary schools to raise awareness of the impact of uncorrected refractive errors among children and their parents. In addition, early management to prevent avoidable visual impairment should be emphasized at an early age. A cost-effective strategy is required to minimize correctable visual impairments in children. More public health strategies should be targeted at school children in this age group to reduce the prevalence of refractive error. However, in this study, we failed to

record other factors, such as family inheritance, ethnicity, or environmental factors, or their associations with the prevalence or type of refractive error. Future studies should involve an equal proportion of different ethnicities and record details of environmental factors to study the refractive error and contributing factors among various ethnicities. Further study with a larger sample size is recommended to investigate the effects of family background and environmental factors.

CONCLUSIONS

The prevalence of refractive error among primary school children in Wangsa Maju Township, Kuala Lumpur, Malaysia was 47.8%. Myopia was the most common, followed by astigmatism and hyperopia. Reduced UCDVA had a strong positive correlation with refractive error. The magnitude of the three types of refractive error showed no sex differences among those with refractive errors. This prevalence rate was considerable; therefore, the government and optometry associations should work together to conduct annual vision screening and eye health programs in government primary schools to raise awareness of the impact of uncorrected refractive errors among children and their parents and prevent visual impairment in those school children. Future population-based studies are required to address the study limitations concerning the impact of environmental risk factors, ethnicity, and familial background on the prevalence of refractive errors in a similar but larger population using the same protocol.

ETHICAL DECLARATIONS

Ethical approval: The study protocol was approved by the Ethics Committee of the Faculty of Medicine and Health Sciences, UCSI University on April 14, 2017 (approval number: IEC-2017-FMHS-031). Informed consent was obtained from parents or legal guardians before commencement of the study.
Conflict of interest: None.

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