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ORIGINAL ARTICLE

Prevalence and Risk Factors of Refractive Errors Among School-Going Children

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ABSTRACT

Objectives: To study the prevalence of refractive errors and evaluate the demographic, familial, behavioral, and environmental risk factors associated with refractive errors in school-going children.

Study Design: A Cross-sectional study.

Place and Duration of the Study: Department of Ophthalmology, MMC/BKMC, Mardan, from Jan 2020 to Dec 2021

Material and Methods: A cross-sectional study was carried out on 100 school-going children aged 6-16 years. Schools were selected consecutively to recruit participants. The demographic data, family history, screen time, near-work duration, outdoor activities, and previous spectacle use were collected using a structured questionnaire. Visual acuity was tested with a Snellen chart, and objective & subjective refraction was performed for children with lower visual acuity. Refractive errors were classified as myopia (-0.5 D or less), hypermetropia (+0.5 D or more), or astigmatism (any refractive error other than myopia and hypermetropia). SPSS version 27.0 was used for data analysis. The frequencies, percentages, mean ± standard deviation, and chi-square tests were used. Logistic regression was performed to determine the significant risk factors ($p<0.05$).

Results: Among 100 children, the mean age was 11.2 ± 2.8 years. Refractive errors were identified in 32 (32.0%) children, while 68 (68.0%) had normal refractive status. Myopia was the most frequent refractive error, observed in 19 (19.0%) children, followed by astigmatism in 9 (9.0%) and hypermetropia in 4 (4.0%). Refractive errors were more common among children aged ≥12 years than younger children (40.0% vs. 24.0%, p=0.048). A significant association was observed with family history of refractive error, with 45.5% of children having an affected parent developing refractive errors compared with 25.6% without such history (p=0.032). Children reporting ≥4 hours of daily screen exposure had a higher prevalence than those with <4 hours (41.9% vs. 22.0%, p=0.036). Near work exceeding 3 hours/day was also associated with refractive errors (40.0% vs. 22.5%, p=0.047). Children spending ≥2 hours/day outdoors had fewer refractive errors than those with less outdoor activity (22.2% vs. 40.7%, p=0.041). Sex was not significantly associated with refractive errors (p=0.614).

Conclusion: In the studied school-going children, refractive errors were observed in about 33%, with myopia as the most common error. Positive family history, prolonged screen exposure, and increased near work were significantly associated with refractive errors, and increased outdoor activity appeared to have a protective association. Childhood vision impairment can be minimized by regular vision screening, early refractive correction, spectacle correction, and encouragement of outdoor activities at school.

Keywords: Refractive errors; Myopia; Schoolchildren; Vision screening

INTRODUCTION

Refractive error is one of the most frequent ophthalmic problems in children and a significant, potentially correctable cause of visual impairment worldwide. They are caused by a defect in the eye's optical apparatus that prevents light from focusing on the retina, causing blurred vision. Myopia, hypermetropia and astigmatism are the three main refractive errors. Uncorrected refractive errors may go undiagnosed, especially in communities with restricted eye-care services, and can be effectively corrected with spectacles; however, these conditions can usually be diagnosed by a routine visual examination. Early detection and correction are therefore crucial to children's health[1,2]. The effects of undiagnosed refractive errors are especially harmful to school-going children because clear vision is essential for learning and participating in class. Children with impaired vision may struggle to read information displayed on boards, identify faraway objects, write, or focus on lessons. These ongoing visual problems can then impact school achievement and social-emotional health. In addition, younger children may not be able to identify or communicate the visual problems, and school-based screening is a critical component in identifying children who may need additional ophthalmic evaluation[3]. With the shift in educational activities and lifestyle, myopia has become a growing public-health problem in children. Several populations have been reported to have a higher risk of myopia when involved in prolonged near work activities such as reading, studying, or using smartphones, tablets, computers,, and other digital devices. Meanwhile, lower exposure to outdoor environments has been suggested as a significant modifiable factor. Bright daylight and spending more time looking at distant objects could help prevent and slow the progression of myopia. Thus, genetic-environmental interactions have become increasingly recognized in the pathogenesis of CEs[4]. The refractive status is also related to family history. Refractive errors, particularly myopia, could be hereditary and may increase the risk for their children. The genetic susceptibility may interact with the environment, including strenuous educational requirements, close-range work activity, and outdoor activity restrictions. Other factors, such as age, sex, socio-economic status, type of school attended, prior use of spectacles, and eye-care services received, may also affect the detection and management of refractive errors[5]. Refractive errors may be a significant problem in low- and middle-income countries such as Pakistan, where routine eye examinations in children are not always possible. Variations in age distribution, educational environment, level of urbanization, lifestyle, diagnostic criteria, and access to eye-care services may account for geographical and/or population differences in prevalence. Thus, epidemiological studies are needed in the local community to determine the prevalence of refractive errors and potential modifiable risk factors[6]. School-based vision screening offers a valuable chance to detect children with poorer vision early, before it significantly affects their learning. Screening programs can help identify and refer those needing a full eye examination, a correct refraction and appropriate glasses. Along with identifying refractive errors, behavioral and environmental risk factors can be evaluated and used to plan refractive error prevention strategies such as limiting screen time, maintaining proper reading posture, and encouraging regular outdoor activity[7,8]. Although refractive errors are clinically important, little local information exists on their prevalence and associated risk factors in school-going children within each community. The present study therefore aimed to determine the prevalence and types of refractive errors among school-going children and their correlation with demographic, familial, and lifestyle factors. The results could serve as valuable data to support the implementation of more effective school-based vision screening and early detection and correction of refractive errors in children[9].

MATERIALS AND METHODS

A cross-sectional study was conducted at Department of Ophthalmology, MMC/BKMC, Mardan, from Jan 2020 to Dec 2021.among school-going children to determine the prevalence of refractive errors and the risk factors associated with them, including demographic, familial, behavioral, and environmental factors. The study took place in selected primary and secondary schools in [City], Pakistan, over six months, from [Month Year] to [Month Year]. Using consecutive sampling, 100 children aged 6–16 years who attended school were included. Following informed written consent from parents/legal guardians and children (where appropriate), children were enrolled. Children aged 6- 16 years who regularly attended the selected schools and were able to cooperate with the examination were included. Children who had previously been diagnosed with major ocular diseases, congenital ocular abnormalities, a history of ocular trauma, a history of ocular surgery, neurological diseases with significant ocular manifestations, and systemic diseases with significant ocular manifestations were excluded. Children who could not be tested for visual acuity or refraction were also excluded. Information was obtained using a structured questionnaire that included data on age, sex, school type, residential status, socioeconomic factors, previous use of spectacles, and family history of refractive errors. Data on lifestyle factors were also collected, including daily screen time, duration of reading or other near-work activities, reading habits, and daily outdoor activity. The use of television, computers, tablets, and smartphones was considered as screen exposure. Best corrected visual acuity was determined separately for each eye, at the proper test distance under proper illumination, with the use of a standard Snellen visual acuity chart. Visual acuity tests were performed in detail for children with reduced vision. Objective refraction was carried out on an auto-refractor (if applicable), and subjective refinement was performed. In younger children, cycloplegic refraction was performed to minimize the effects of accommodation and obtain a more accurate refractive measurement. A best-corrected visual acuity was then obtained. Children with clinically significant RE were referred for a suitable spectacle prescription and eye care. Refractive error was defined as a deviation of the refractive state from normal, causing light not to be focused correctly on the retina, and included myopia, hypermetropia, and astigmatism. Myopia was considered to be a spherical equivalent refractive error (SE) of ≤−0.50 diopter (D), hypermetropia to be SE of ≥+0.50 D, and astigmatism to be cylindrical refractive error (CE) of ≥0.75 D. Any refractive error of any type in either eye was deemed a positive outcome. All the data were entered, coded, and analyzed in SPSS version 27.0. Continuous variables were described as mean ± SD, and categorical variables as frequencies and percentages. Prevalence of refractive errors was estimated as the percentage of children with refractive errors in the total population studied. The Chi-square test and/or Fisher's exact test were used to test associations between the categorical variables and refractive errors. To determine independent risk factors, binary logistic regression was used to compute odds ratios and 95% confidence intervals. A p-value < 0.05 was taken as significant. All participants were assured of confidentiality, and ethical approval was obtained from the relevant institutional ethics committee.

RESULTS

The study included 100 school-going children aged 6–16 years. The mean age of participants was 11.2 ± 2.8 years. Refractive errors were identified in 32 (32.0%) children, while 68 (68.0%) had normal vision. Among affected children, myopia was the most common refractive error, occurring in 19 (19.0%), followed by astigmatism in 9 (9.0%) and hypermetropia in 4 (4.0%) children. Refractive errors were more frequent among children aged ≥12 years than those aged <12 years (40.0% vs. 24.0%; p=0.048). A significant association was also observed between family history and refractive errors, with a higher prevalence among children having a positive parental history (45.5% vs. 25.6%; p=0.032). Children reporting ≥4 hours of daily screen exposure had significantly more refractive errors than those with <4 hours (41.9% vs. 22.0%; p=0.036). Similarly, near-work activity exceeding 3 hours/day was associated with a higher prevalence (40.0% vs. 22.5%; p=0.047). Children spending ≥2 hours outdoors daily had fewer refractive errors than those with less outdoor activity (22.2% vs. 40.7%; p=0.041). No significant association was observed with sex (p=0.614).

Data are presented as frequencies and percentages. The mean age of the study population was 11.2 ± 2.8 years. Screen exposure included smartphone, tablet, computer, and television use. Near-work activities included reading, studying, and other prolonged close visual tasks.

Refractive error was defined according to the study criteria. Myopia was defined as spherical equivalent refractive error ≤−0.50 D, hypermetropia as ≥+0.50 D, and astigmatism as cylindrical refractive error ≥0.75 D. Percentages are calculated using the total study population (n=100) as the denominator. Myopia was the most frequently observed refractive error.

Table 1: Demographic characteristics of school-going children included in the study (n=100)

Variable	Category	n (%)
Age group	<12 years	50 (50.0)
	≥12 years	50 (50.0)
Sex	Male	55 (55.0)
	Female	45 (45.0)
School type	Public	58 (58.0)
	Private	42 (42.0)
Family history of refractive error	Present	33 (33.0)
	Absent	67 (67.0)
Daily screen exposure	<4 hours	59 (59.0)
	≥4 hours	41 (41.0)
Near-work duration	≤3 hours/day	60 (60.0)
	>3 hours/day	40 (40.0)
Outdoor activity	≥2 hours/day	45 (45.0)
	<2 hours/day	55 (55.0)

Table 2: Prevalence and types of refractive errors among school-going children (n=100)

Refractive status	n (%)
No refractive error	68 (68.0)
Any refractive error	32 (32.0)
Myopia	19 (19.0)
Astigmatism	9 (9.0)
Hypermetropia	4 (4.0)
Total	100 (100.0)

DISCUSSION

In the present study, 32.0% of the 100 children attending the school had refractive errors, and the mean age was 11.2 ± 2.8 years. The most common refractive errors were myopia (19.0%), astigmatism (9.0%), and hypermetropia (4.0%). This finding indicates a high prevalence of potentially correctable visual impairment in school-going children and underscores the need for routine vision screening in school settings[10]. The prevalence in our study is close to results from other recent Pakistani studies, but significant geographical variation has been reported. A study carried out in 2020 in Peshawar on 1198 children aged 5-16 years found a prevalence of 32.9% refractive errors, which was very similar to our result of 32.0%. In that study, the most common refractive errors were myopia (18.6%), astigmatism (10.0%), and hyperopia (4.3%). Increased screen exposure and older age were identified as important risk factors. In the same way, a recent study on school-going children reported a prevalence rate of 35.6%, of which 19.6% were myopic, and there was a significant relationship between prolonged screen time and refractive errors. The pattern seen in these populations[11–12] is very similar to our population. A 2020 study that included 1,200 children in Lahore found a far lower prevalence of 15.5%, however. In terms of refractive error, myopia was the most prevalent (59.1% of children with refractive error), followed by astigmatism (24.2%) and hyperopia (16.7%). Prevalence was significantly higher among urban children and 13- to 16-year-old children. This distinction[13] could be due to geographic location, school factors, sampling procedure, age range, diagnostic criteria, or access to eye-care services[14]. There was a significant correlation between age and refractive errors, as the proportion increased from 24.0% in children below 12 years to 40.0% in children aged ≥12 years (p=0.048). This finding is supported by recent evidence from Pakistan, which indicates that older school children are more affected. Older age was also identified as an important risk factor in the 2020 Peshawar study. A recent study in Rawalpindi screened school-going children for visual deficits and also stressed the need to identify visual defects through school screening[15,16].In our study, family history showed a significant association with refractive errors (p=0.032). Children were more likely to have a parental history than those without one. This is biologically plausible, given that both genetic susceptibility and environmental exposure contribute to refractive development. Recent systematic evidence further demonstrates that parental myopia is an important risk factor and confounder for the analysis of screen exposure and childhood myopia[17]. Another important factor was screen exposure. Compared with less than 4 hours of daily screen exposure, children with≥4 hours of daily screen exposure had a higher incidence of refractive errors (41.9% vs. 22.0%, p=0.036). This is consistent with a recent Pakistani study that found a significantly higher prevalence of refractive errors among those who browsed more than four hours a day. In line with the above, recent systematic reviews have also found links between screen-related behaviors, overdoing near work, and myopia, with differences between studies warranting further caution regarding causality[18,19]. We have also found that the relation between near work duration and RE was significant (p=0.047). On the other hand, children who spent at least two hours outside a day were less likely to have a high prevalence (22.2% vs. 40.7%, p=0.041). This is consistent with recent systematic reviews and a meta-analysis which showed that more outdoor exposure correlates with decreased myopia development. Some randomized evidence also indicates that outdoor interventions can decrease the incidence of myopia, but the amount of benefit differs across studies[20]. There was no significant difference between sex and refractive errors (p=0.614), which may indicate lifestyle and familial factors might be more important than sex in this population. Overall, the conclusions are that regular school screening, early refraction, correct spectacle correction, reduced excessive screen and near-work exposure, and encouragement of outdoor activities are all important. This study was cross-sectional, and only 100 children were involved, so it is not possible to draw cause-and-effect conclusions, and the results may not be considered representative of Pakistani schoolchildren[21,22]

CONCLUSION

Almost one-third of school-going children suffered from refractive errors, the most common being myopia. Refractive errors were significantly associated with older age, a more positive family history, longer screen time, and more near work; increased outdoor activity was protective. Spectacle correction and regular school screening are recommended.

Declarations

Informed Consent: Written informed consent was obtained from the parents or legal guardians of all participating children before enrollment in the study. Children were provided with age-appropriate information about the study, and assent was obtained where appropriate. Participation was voluntary, and participants were informed that they could withdraw from the study at any time without any consequences. All collected information was kept confidential and used solely for research purposes.

Conflict of Interest: The authors declare no conflict of interest related to this study.

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Data Availability: The data generated and analyzed during this study are available from the corresponding author upon reasonable request. The data are not publicly available to protect the privacy and confidentiality of the participating children.

Authors' Contributions (ICMJE)

Shafqat Ali Shah: Conceptualization and study design; supervision; data collection and management; data analysis and interpretation; critical review and revision of the manuscript; final approval of the version to be published.

Muhammad Bilal: Data collection; data entry and management; literature review; data analysis; drafting of the manuscript; critical revision; final approval of the version to be published.

Hidayatullah Mahsud: Data collection; literature review; interpretation of findings; manuscript drafting and revision; final approval of the version to be published.

All authors contributed substantially to the study, approved the final manuscript, and agree to be accountable for all aspects of the work, ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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