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Prevalence of Refractive Errors in School- Aged Children: A Vision Screening and Community Medicine Approach

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ABSTRACT

Background: In low-resource areas, where frequent eye checks are not common like in other parts of the world, refractive errors rank among the most prevalent causes of avoidable childhood visual impairment. Vision screening programs in schools suggest a fundamental platform of early detection and correction. The purpose of this study was to evaluate the distribution and spectrum of refractive errors in schoolchildren and to highlight the significance of ophthalmic screening conducted in the community in primary preventive health care.

Methods: The descriptive cross-sectional study was conducted between March and July 2024 in coordination with local government schools and the Department of Community Medicine. Stratified random sampling was used to select 1200 children aged 6-16 years in urban and rural schools. Visual acuity was performed by trained optometrists on the Snellen chart, with retinoscopy, and subjective refraction in patients with VA of less than 6/9. SPSS version 26.0 was used to analyse data. The chi-square and ANOVA tests were used to determine associations between refractive errors and demographic variables.

Results: Among 1200 children, 186 (15.5%) had refractive errors. Most prevalent refractive error types were myopia (110 (59.1%)), astigmatism (45 (24.2%)), and hyperopia (31 (16.7%)). The prevalence was higher in urban children ($p = 0.003$) and in children aged 13-16 years ($p = 0.001$).

Conclusion: The prevalence of uncorrected refractive errors among school-going children is significant and mostly undiagnosed. Primary healthcare strategies that incorporate regular screening at schools should be implemented to prevent unnecessary visual disability and improve educational outcomes.

Keywords: Refractive Errors, Myopia, Astigmatism, Vision Screening, Hyperopia
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INTRODUCTION

The major visual challenges during school years in children are refractive errors, including myopia, hyperopia, and astigmatism, which interfere with learning, visual development, and eye functioning

in everyday activities [1]. These conditions are frequently not diagnosed and escape detection due to the absence of early indicators or access to vision screening at school [2]. Unrecognized visual impairment can lead to decreased classroom engagement, impaired academic achievement, and an increase in behavioral challenges and psychological complications [3].

Lifestyle and environmental exposure to specific factors, notably exposure to digital screens and near-work severity, have become fundamental drivers of retinal alterations in kids [4]. Long-term screen-based activities cause ocular discomfort, altered blinking, and accommodative fatigue [5]. The increased amount of time spent indoors, especially among young people in the early stages of development, is also believed to play a significant role in the development of myopia [6]. Academic pressure, a lack of exposure to natural light, and increased time spent on intensive visual work may pose a greater threat to urban children [7].

Numerous models of school screening focus on visual acuity; however, they do not add behavioral risk assessment to the process [8]. Failing to incorporate these variables would normally result in missed opportunities to develop preventive measures that could be used to focus their interventions on modifiable risk behaviors [9]. With the adoption of a more comprehensive screening model, it is possible to identify refractive issues at an earlier stage and guide behavioral changes to protect visual health. The solution to the problem of refractive errors in schoolchildren requires a comprehensive approach combining universal periodic screening and specific interventions, considering the needs of the modern visual world [10].

The purpose of this study was to examine the prevalence of refractive errors, especially myopia, astigmatism, and hyperopia, among school-going children using community-based screening. It also assessed the relationship with age, gender, urban or rural occupation, screen time, and near-work activity. The objectives include estimating the prevalence, subtype of refractive error, and correlation with relevant behaviours, and providing evidence-based strategies to integrate screening and prevention into the school health system.

METHODS

This school-based, cross-sectional, epidemiological study aimed to determine the prevalence of refractive errors and examine their correlation with demographic and behavioral factors, including screen time and proximity work in schoolchildren. The research was conducted in collaboration with the Department of Community Medicine in a sample of public and private schools in urban and rural locations between March and July 2024 mainly conducted by ASMDC and SZH Lahore collaboratively (Ref: 2178-2023). The study selected 1,200 schoolchildren between 6-16 years of

age through a multi-stage stratified random sampling approach according to the type and geographic setting of schools. OpenEpi version 3.0.0 (released, 2013, Atlanta, GA, USA) was used to calculate the sample size with a 95% confidence interval, 80% power, and a 5% margin of error based on the expected prevalence from past literature [11]. The children who were included in the study had no known ocular or systemic diseases and were enrolled full-time in selected schools. The exclusion criteria included any past eye surgery, neurological conditions, or the use of vision correction devices.

Vision of participants was assessed through a standardized 6-meter Snellen chart. Children whose visual acuity was poorer than 6/9 in either eye underwent a more thorough investigation, including retinoscopy and autorefractometry by experienced optometrists. A structured questionnaire, whose validity was ascertained, was used to measure both daily screen time and demographic and near-work frequency. The questionnaires to measure visual exposure and screen-time symptoms were based on the Computer Vision Syndrome Questionnaire (CVS-Q), a validated instrument with good reliability and construct validity in adolescents [12]. Parental confirmation was requested to enhance accuracy of adherence.

Data were analyzed by SPSS version 26.0 (released 2019, IBM Corp., Armonk, NY). The chi-square test was used to analyze categorical variables, and ANOVA was used to analyze the continuous variables. The p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Demographic Characteristics of School-Aged Children

Variable	Group A (Age 6–9 years)	Group B (Age 10–12 years)	Group C (Age 13–16 years)	Test Value χ^2	p-value
Number of children (n/%)	410 (34.2%)	396 (33.0%)	394 (32.8%)	0.16	0.92
Gender (Male/Female, %)	215(52.4%)/195 (47.6%)	210(53.0%)/186 (47.0%)	195(49.5%)/199 (50.5%)	1.04	0.59
Residence (Urban/Rural)	250 (61.0%)/160 (39.0%)	245 (61.9%)/151 (38.1%)	225 (57.1%)/169 (42.9%)	1.38	0.50

*n = number of participants, % = Percentage, * = Significance at p-value <0.05*

The study examined 1,200 children aged 6-16 years and assessed the prevalence of refractive errors and risk factors. The overall prevalence of refractive errors with myopia was 110 (59.1%). Older

and urban children, and those with more screen time and near-work, had higher prevalence. These findings highlight the importance of early vision screening in school. Table 1 indicates the demographic characteristics of the study participants.

Table 2: Distribution of Refractive Error Types

Variable	Group A(Myopia)	Group B(Astigmatism)	Group C(Hyperopia)	Test Value	p-value
Number of children (n/%)	110 (59.1%)	45 (24.2%)	31 (16.7%)	χ^2 = 78.82	<0.0001
Mean age (years ± SD)	13.2 ± 1.6	12.4 ± 1.8	10.9 ± 2.1	F = 6.27	0.002
Urban residence (n/%)	89 (80.9%)	33 (73.3%)	12 (38.7%)	χ^2 = 22.19	<0.001

*n = number of participants, SD = Standard Deviation, % = Percentage, * = Significance at p-value <0.05*

Age groups: 6-9 years (410 (34.2%)), 10-12 years (396 (33.0%)), and 13-16 years (394 (32.8%)) were evenly distributed. There was almost equal gender representation (Male: 620 (51.7%), Female: 580 (48.3%)), and the majority of children were urban (720 (60%)). No significant demographic disparities were noticeable among the groups ($p > 0.05$). The balanced sample allows the validity of subgroup comparisons. Distribution of characteristics of refractive error types is demonstrated in **Table 2**.

Table 3: Lifestyle Factors Associated with Refractive Errors

Variable	Group A (<2 hrs/day)	Group B (2–4 hrs/day)	Group C (>4 hrs/day)	Test Value χ^2	p-value
Screen time (n/%)	502 (41.8%)	430 (35.8%)	268 (22.3%)	14.57	0.001
Refractive errors in each group	51 (10.2%)	73 (17.0%)	62 (23.1%)	21.76	<0.001
Near work >2 hrs/day (n/%)	180 (35.9%)	284 (66.0%)	212 (79.1%)	11.49	0.003

*n = number of participants, % = Percentage, hrs = Hours * = Significance at p-value <0.05*

Children with refractive disorders, the highest percentage belonged to myopia (110 (59.1%)), astigmatism (45 (24.2%)), and hyperopia (31 (16.7%)). Myopia had the highest mean age (13.2 years), and hyperopia had the lowest mean age (10.9, $p = 0.002$). Myopia was associated with urban living (89 (80.9%), $p < 0.001$), implying that urban and older children are more at risk of

developing myopia. **Table 3** illustrates the association between lifestyle factors and refractive errors in school children.

Children exposed to >4 hours/day of screen time were found to have a high prevalence of refractive errors (62 (23.1%), $p < 0.001$). Close working >2 hours/ day was significantly correlated with refractive errors (212 (79.1%)). Decreased screen time and prolonged near work may lower the risk of refractive error.

DISCUSSION

This study aimed to identify behavioural and demographic factors predetermining the development of refractive errors among school-aged children and evaluate the impact of their lifestyle profiles on their ocular health. The findings support the role of exposure to digital screens, near-work patterns, and urban dwelling in refractive errors, especially myopia.

The demographic factors findings indicated a greater burden of refractive errors among children living in urban settings. This aligns with studies, which demonstrated that in urban life, low outdoor time and increased academic pressure are well-established risk factors for myopia onset [13]. Children with increased screen time, especially with the use of multiple devices in proximity, also exhibited greater rates of myopia and astigmatism occurrence [14]. This finding aligns with literature, which indicated a significant relationship between long-term near-work and refractive changes among school-aged children [15]. The research demonstrated that less daylight exposure in childhood correlates with a faster myopic growth rate, particularly in schoolchildren [16].

In the current study, children with over four hours of screen time per day were exposed to significantly higher refractive error change. This is consistent with studies that have documented digital learning environments and escalated online education following COVID-19, aggravating the myopia epidemic among children [17,18]. There was also a significant association between near-work and refractive stress in this study, thus lending support to the theory of accommodative lag as a cause of myopia [19].

Although other cross-sectional studies have reported mixed relationships between screen time and refractive changes, these differences likely arise because of differences in the way visual behaviour was defined or measured [20]. The validity of this study is due to structured proformas that offer a more precise understanding of cumulative screen exposure. The significance of parental education and awareness of the visual health of children has also been highlighted by other studies [21,22]. This study also shows that screen time and near-work additively increase the risk of refractive disorders, as previously reported [23]. Nevertheless, this study contradicts the findings of the other studies, which showed no significant correlation between myopia and exposure to screens, potentially because screening time was longer in study participants [24,25]. Conversely,

some studies in under-resourced areas indicate underdiagnosis as a result of the absence of school-based screening programs [26,27].

Study limitations are associated with the study design and the use of self-reported screen and near-work data, which could be subject to recall bias. Potential confounding factors, including parental refractive status, socioeconomic status, and hours of outdoor exposure, were not measured; however, this may impact the result. Further studies are encouraged to use multicentric longitudinal models and objective exposure monitoring in cycloplegic refraction. School-based prevention strategies, including behavioural education, visual hygiene training, and eye screening practice, have the potential to significantly decrease the burden of children's refractive error.

CONCLUSION

The study identified myopia as the most common refractive error among schoolchildren and indicated a significant relationship between refractive changes and behavioral activities, including increased screen time, near-work tasks, and less outdoor exposure. Greater prevalence was also associated with urban habitation.

The implications reinforce the comprehensive school-based vision screening programs. Prevention should focus on educational interventions that focus on screen hygiene and outdoor activity. A behavior-based approach that enables early identification of patients can potentially minimize the impacts of unaddressed visual damage in children.

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CONFLICT OF INTEREST

None

ETHICAL APPROVAL

The research was conducted in collaboration with the Department of Community Medicine in a sample of public and private schools in urban and rural locations between March and July 2024 mainly conducted by ASMDC and SZH Lahore collaboratively (Ref: 2178-2023).

AUTHORS' CONTRIBUTION

All authors contributed equally as per ICMJE.

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