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Prevalence and pattern of refractive errors among primary school children in urban and rural areas

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Abstract
Background: Refractive error is one of the commonest causes of visual impairment among school-aged children all over the world, which can lead to poor academic performance and quality of life when left untreated. The epidemiology of refractive error varies with geographical location; lifestyle and availability of eye care services vary, and there are major differences between urban and rural areas.
Objective: This study aimed to estimate the prevalence, types and severity of refractive errors among 6-12 years old urban and rural primary school children in Tikrit city, Iraq, and evaluate any associated ocular abnormalities.
Method: A cross-sectional observational study was carried out for 10 months between January,2025 to October,2025. A sample size of 400 primary school children was selected through stratified random sampling with equal allocation between urban and rural (200 students in each category). Primary school screening was succeeded by complete ophthalmologic examination at Tikrit Teaching Hospital and in private clinic. Examinations included visual acuity measurement, cycloplegic retinoscopy and auto refraction, slit-lamp evaluation, ocular alignment testing, and fundus examination. Refractive errors were categorized according to spherical equivalent.
Results: Refractive error was found in 148 children with an overall prevalence of 37.0%. Urban children showed a higher prevalence (45.0%) than their rural counterparts (29.0%). The most frequent refractive error in urban population was myopia (43.2%) followed by hypermetropia (31.1%), and astigmatism (25.7%). The prevalence of such lesions was slightly higher among females than males, but the difference was to be not statistically significant. The refractive errors were predominantly mild to moderate in nature and no posterior segment pathology was observed.
Conclusions: Refractive errors are common among primary school students in Tikrit and they have more refractive errors in urban compared with rural children. The most common refractive error was myopia. These results support the requirement for school-vision screening programs and early treatment intervention in order to avoid potential avoidable visual impairment and increased academic underachievement.

Keywords: Refractive errors, school children, myopia, urban and rural, vision screening

1. Introduction
Vision is critical for the physical, cognitive and social development of children. Good vision is so important during the primary school years as it's critical to a child's visual skill set and plays an integral part in learning, reading, writing and fully participating in the classroom. Refractive errors are one of the most prevalent eye diseases in children and a serious public health problem across the world [1]. Although they are easily detectable and correctable, uncorrected refractive errors continue to be a significant cause of visual impairment in the school-aged population, particularly in developing nations [2].
Refractive errors happen when the eye cannot focus the light that comes in and blurred vision occurs. The most frequent ones include short-sightedness (myopia), long sightedness (hypermetropia) and astigmatism [3]. If not treated, they can affect school performance and result in discomfort, headaches, inability to concentrate or even amblyopia (lazy eye) or permanent vision loss. Early recognition and prompt treatment are necessary to avoid the long-term visual and educational effects [4].
In-school visual screening programs are known as one of the most effective measures to detect refractive errors early. Primary school aged children are an ideal population in which to conduct such screenings [5], as the visual load is quite large at this age and children are often unable to articulate their visual problems. A large number of children with refractive errors accept poor vision as part of their life and live under the belief that nothing can be done [6].

The prevalence and pattern of refractive errors varies widely among diverse populations as a result of numerous factors such as age, sex, genetic propensity, environment and lifestyle. Alterations in children's lifestyles, such as more near work and longer exposure to digital screens, have been related with increasing myopic refractive error [7]. These findings underscore the need for ongoing surveillance of refractive error patterns in various populations.

In several studies [8-10], differences between urban population and rural one who often have higher prevalence of refractive errors in urban children compared with their counterpart were reported. Such a discrepancy can be explained by differences in the financial status of both social groups, access to medical facilities, educational requirements, environmental exposure, and habits. Urban kids are more likely to do near-vision activities and have greater access to digital devices Whereas rural children may not get eye care services due to which there could be underdiagnosis and untreated vision difficulties.

Knowledge on distribution and pattern of ametropia among primary school children in urban and rural areas is important for designing efficient eye care services as well as preventive measures. These type of data on prevalence and types of refractive errors are essential in order to help health authorities and decision-makers to design appropriate school eye health programs, distribute resources appropriately, sensitize parents, teachers and other care givers about the need for early examination of the eye [11].

Additionally, determining the most prevalent types of refractive errors in diverse environments may assist to inform policy and programmatic actions such as prescribing spectacles, and following up those founder corrective spectacles. Correction of refractive errors in early childhood not only increases the visual outcomes but also improves the academic achievements, quality of life and well-being of children [12].

This research aimed to identify the prevalence and pattern of refractive errors in primary school children in urban and rural settings, as well as compare the distribution of specific types of refractive error between these groups as a basis for planning effective strategies for early detection and intervention.

2. Methodology

2.1 Study Design and Setting

It was a cross-sectional, observational study conducted over a period of 10 months, from January 2025 to October 2025, to determine the prevalence and pattern of refractive errors among urban and rural school children. The study was carried out at two main sites: the Department of Ophthalmology at Tikrit Teaching Hospital and the researcher's private eye clinic. Both facilities are fully equipped for comprehensive ocular examinations and serve children from diverse socioeconomic backgrounds, making them suitable settings for this epidemiological study.

2.2 Study Population and Sampling

The study population consisted of primary school children aged 6–12 years. A total of 400 participants were recruited using a multistage stratified random sampling technique from both urban and rural areas. The sample included 200 children from urban schools and 200 children from rural schools within Tikrit city and its surrounding villages.

Invitation letters explaining the purpose, procedures, and benefits of the study were distributed to parents or guardians through the schools. Written informed consent was obtained from parents or guardians prior to enrollment, along with verbal assent from the participating children.

2.3 Inclusion and Exclusion Criteria

Children were eligible for inclusion if they were enrolled in primary school, within the specified age range, and present during the scheduled screening visits. Exclusion criteria included children with known ocular diseases unrelated to refractive errors (such as congenital ocular anomalies or active eye infections), a history of ocular surgery, or inability to cooperate with vision testing due to cognitive or physical disabilities.

2.4 Data Collection Procedure

There were two main parts to collecting data: vision screenings at schools and full clinical exams.

2.4.1 School-Based Vision Screening

Trained optometry technicians did the first vision screenings at certain schools. A standardized Snellen chart or LEA symbols for younger children who couldn't read letters were used to test distance visual acuity in one eye. Children exhibiting visual acuity of 6/9 (20/30) or inferior in either eye were referred for additional ophthalmic assessment. Using a standard data collection form, we recorded demographic information such as age, sex, school grade, and area of residence (urban or rural), as well as a short history of eye problems.

2.4.2 Clinical Examinations

At Tikrit Teaching Hospital or the private eye clinic, children who were sent there by school screening or whose parents chose to have them checked out directly were seen. An ophthalmologist and a licensed optometrist did the tests, which included the following:

2.4.2.1 Visual Acuity Assessment

Using a Snellen chart at a distance of 6 meters, we measured distance visual acuity in standard lighting conditions. When it made sense, LEA symbols or tumbling E charts were used. A Jaeger chart was used to test near visual acuity.

2.4.2.2 Objective Refraction

We did objective refraction with a handheld auto-refractor (when one was available) and then checked it with streak retinoscopy. To get accurate measurements of children's refractive errors, cycloplegia was caused by using 1% cyclopentolate eye drops. Retinoscopy was conducted in a poorly lit room.

2.4.2.3 Subjective Refraction

When the child was developmentally ready to cooperate, subjective refraction was done to improve the objective results using trial lenses and a phoropter.

2.4.2.4 Anterior Segment Examination

We used a slit-lamp biomicroscope to look at the front part of the eye, which includes the eyelids, conjunctiva, cornea, anterior chamber, iris, and lens. This was to make sure there were no problems that could affect vision.

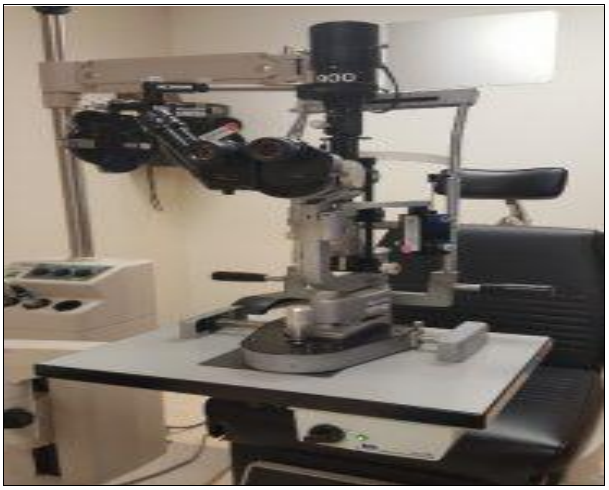

Fig 1: Slit-lamp examination and retinoscopy

2.4.2.5 Ocular Alignment and Binocular Vision Assessment

We used to cover-uncover and alternate cover tests to check for ocular alignment and binocular vision. Prism testing, near point of convergence, and stereopsis tests were conducted as necessary.

2.4.3 Fundus Examination

After pharmacological pupil dilation, an indirect ophthalmoscopy was done to look at the retina, macula, and optic nerve head and rule out any problems in the back of the eye.

2.5 Definition and Classification of Refractive Errors

Refractive errors were defined based on spherical equivalent measurements as follows:

- Myopia: spherical equivalent ≤ −0.50 diopters (D)
- Hyperopia: spherical equivalent ≥ +2.00 D
- Astigmatism: cylindrical error ≥ 0.75 D in any axis

Children diagnosed with refractive errors were prescribed appropriate corrective spectacles.

2.6 Quality Control and Standardization

To make sure that all examiners used the same techniques, they all went through pre-study training and calibration sessions. The study followed standard procedures the whole time. All instruments were regularly calibrated in line with the manufacturer's instructions. Double-entry methods were used to enter data to cut down on mistakes.

2.7 Ethical Considerations

The Ethics Committee of Tikrit Teaching Hospital gave the study its ethical approval. The study followed the rules set out in the Declaration of Helsinki. The privacy and confidentiality of participants were strictly upheld.

2.8 Statistical Analysis

The data was recorded, processed and analyzed using the Statistical Package for Social Sciences (SPSS) program version [22]. Descriptive analysis was conducted to present the sample distribution and the prevalence of various myopia types. Results were reported as frequencies, proportions, where appropriate means and standard deviations.

Refractive errors and their association with categorical variables (age-group, sex and place of residence -urban vs rural) were analyzed using chi-square test. $P < 0.05$ was considered to be statistically significant.

3. Results

3.1 Demographic Characteristics of the Study Population

The number of primary-school children is 400 in all, 200 were urban and the other 200 rural residents. Participants' age ranged between 6 and 12 years (mean, 9.1 ± 1.8 years). Nearly equal proportions of boys and girls were found in both groups. The age-group, gender and place of residence distribution among the study population have been summarized in Table 1.

Table 1: Demographic characteristics of the study population

Variable	Urban (n=200)	Rural (n=200)	Total (n=400)
Mean age (years)	9.2 ± 1.7	9.0 ± 1.9	9.1 ± 1.8
Males	102 (51%)	98 (49%)	200 (50%)
Females	98 (49%)	102 (51%)	200 (50%)
Age 6–8 years	78 (39%)	82 (41%)	160 (40%)
Age 9–10 years	64 (32%)	60 (30%)	124 (31%)
Age 11–12 years	58 (29%)	58 (29%)	116 (29%)

3.2 Prevalence of Refractive Errors

Of the 400 children examined, 148 (37.0%) were identified as having one or more types of refractive errors. Table 2 and Figure 2 show that the prevalence was much higher among urban children (45.0%) than among rural children (29.0%).

Table 2: Prevalence of refractive errors among urban and rural children

Residence	Children examined	Children with refractive errors	Prevalence (%)
Urban	200	90	45.0%
Rural	200	58	29.0%
Total	400	148	37.0%

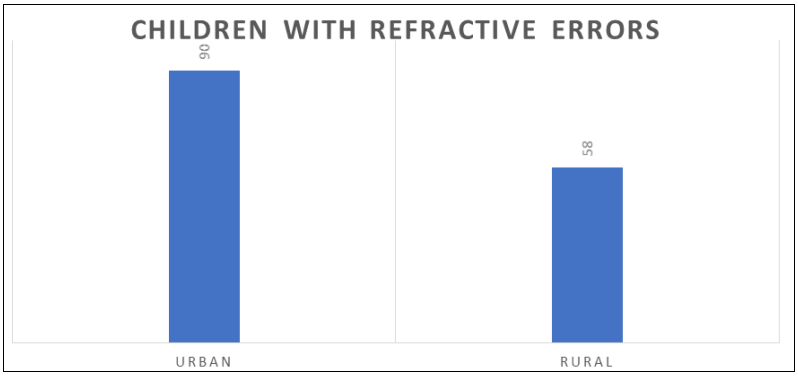

Fig 2: Prevalence of refractive errors among urban and rural children

3.3 Distribution of Types of Refractive Errors

The distribution of refractive errors differed between urban and rural populations. Myopia was the predominant refractive error, especially among urban children, whereas hyperopia and astigmatism were more prevalent in rural regions. Table 3 and Figure 3shows how different types of refractive errors are spread out.

Table 3. Distribution of types of refractive errors among affected children

Type of refractive error	Urban (n=90)	Rural (n=58)	Total (n=148)
Myopia	46 (51.1%)	18 (31.0%)	64 (43.2%)
Hyperopia	24 (26.7%)	22 (37.9%)	46 (31.1%)
Astigmatism	20 (22.2%)	18 (31.1%)	38 (25.7%)

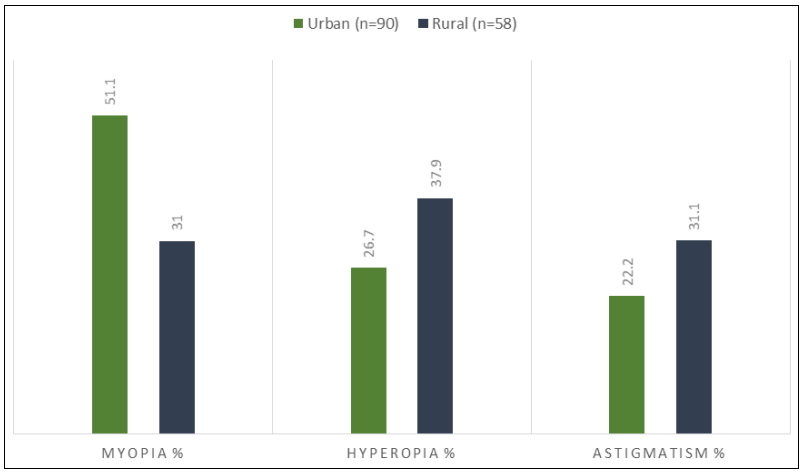

Fig 3: Distribution of types of refractive errors among affected children

3.4 Refractive Errors According to Gender

When investigating the data by gender, it was found that refractive errors were slightly more common in women (39.5%) than in men (34.5%), as shown in Table 4 and Figure 4. But the difference was not statistically significant.

Table 4: Prevalence of refractive errors according to gender

Gender	Total examined	With refractive errors	Prevalence (%)
Males	200	69	34.5%
Females	200	79	39.5%

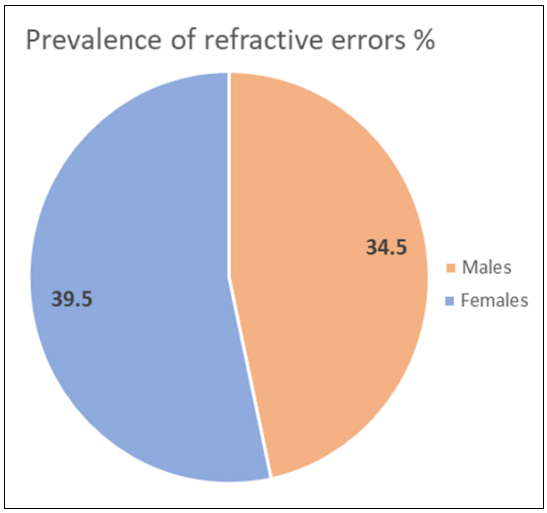

Fig 4: Prevalence of refractive errors according to gender

3.5 Severity of Refractive Errors

The majority of refractive errors were categorized as mild to moderate, based on spherical equivalent measurements acquired via cycloplegic refraction. Severe refractive errors were comparatively infrequent. Table 5 shows how the severity is spread out.

Table 5: Severity of refractive errors among affected children

Severity	Definition (Diopters)	Number of children	Percentage
Mild	≤ ±1.00 D	62	41.9%
Moderate	±1.25 – ±3.00 D	58	39.2%
Severe	> ±3.00 D	28	18.9%

3.6 Associated Ocular Findings

During the clinical examination, ocular alignment abnormalities, primarily mild exophoria, were identified in 12 children (8.1%) with refractive errors. Fundus examination did not reveal any significant pathology in the posterior segment. Table 6 gives a summary of the other eye problems that were found.

Table 6: Associated ocular findings among children with refractive errors

Ocular finding	Number	Percentage
Normal ocular health	136	91.9%
Exophoria	8	5.4%
Esophoria	4	2.7%

Discussion

The above cross-sectional prevalence study is serving as a baseline for future measurements for the magnitude, pattern and severity of refractive errors in primary school children aged 6–12 years in urban and rural Tikrit. The total prevalence of refractive errors among the school aged population within this region was 37.0% suggesting that refractive errors are a major public health problem for school age children in this area.

The prevalence was substantially higher (45.0%) among urban children than in rural children (29.0%). This urban dominance is in line with what has been observed in a number of regional and international studies [13, 14]., who suggested that the higher prevalence in urban areas was related to increase near-work activity, prolonged screen time exposure, less outdoor time and lifestyle changes related to urbanization. Comparable urban–rural discrepancies have been described in reports from China, India and the Middle East [15]. On the other hand, some of the African studies [16] conducted including that a lower overall percentage prevalence and minimal urban–rural differentiation, which could be attributed to differences in education requirements and environmental factors and may account for the inconsistency with our findings.

The prevalence of myopia was highest for the total population and urban children (43.2% and 51.1%, respectively). This tendency is in concert with worldwide reports of an increased prevalence of childhood myopia, particularly in urban areas. Studies [17, 18] have documented a worldwide explosion of myopia, calling it a "global epidemic." By contrast, hyperopia and astigmatism were more common among Chinese rural children in this study, as also reported by [19] who indicated that lower near visual demands or genetic factors may account for the underlying difference.

Although females had marginally higher prevalence of refractive errors than males, it was not statistically significant. This result is consistent with some studies [20, 21] which showed no or little gender difference, while others have indicated higher rates in females, who may be attributed to the behavioral pattern, but also to educational reasons.

The most of refractive errors were mild to moderate which is consistent with those from other nearby countries school-based screening programs. This is indeed a stimulus, as early diagnosis and treatment in this age group can avoid lifelong visual deficiencies and effect on school achievements. The rarity of associated ocular abnormalities and lack of significant posterior segment abnormalities further support the fact that refractive errors were the main cause behind attenuated vision in this group. In general, the results emphasize the need for routine school vision screening programs, especially in urban regions to allow an early detection and immediate management.

Conclusion

This work reveals that there is a very high prevalence of refractive errors among primary schoolchildren in Tikrit, and over one-third of the studied students were affected. The prevalence of refractive errors was significantly higher in the urban children when compared to their rural counterparts and myopia was the commonest refractive error among them, especially among urban children. Hyperopia and astigmatism were proportionally more common in rural children, e so that environmental causes, lifestyle and likely genetic influences affect the spread of these refractive errors.

The majority of refractive errors were of mild to moderate severity, suggesting timely identification by school-based screening, and provision of appropriate refractive services could prevent the occurrence of avoidable visual impairment. The absence of other ocular disease also emphasizes the continued dominance of uncorrected refractive error as the cause for visual impairment in this age group.

In summary, the present study highlights a clear requirement for structured, regular vision screening programs in primary schools especially for urban population. Enhanced linkage between schools, eye care practitioners and health departments is vital to early detection, timely correction, and better vision-related educational achievement for young people. These results constitute an important foundation for planning of public health and future preventive ophthalmic programs in the Middle East.

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Author's Contribution
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Conflict of Interest
Not available

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