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Assessment of Refractive Error among Middle School Children in Rural Meerut: A Cross-Sectional Study

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Abstract: ***Introduction: Eye diseases originating in childhood often go unnoticed, impacting academic performance and potentially causing permanent vision damage. Refractive error, a prevalent visual impairment where the eye fails to focus light correctly, is a significant public health issue. Middle school children (11-14 years) are at a critical stage of visual development, making accurate diagnosis and management of refractive errors essential for their academic and social well-being. Objectives: This study aimed to estimate the prevalence of refractive error among public and private middle school children in Rural Meerut and identify associated risk factors. Methodology: A school-based cross-sectional study was conducted from April 2024 to March 2025 in selected rural Meerut schools. The study population included 350 students from 6th to 8th standard, selected using a multistage sampling method. Data was analyzed using Microsoft Excel and Epi-info software, with associations between qualitative variables assessed using the Chi-square test ($p < 0.05$ considered significant). Results: The prevalence of refractive error was 22.6% among participants, with myopia (19.7%) being the most common type. Significant risk factors included age ($p = 0.0345$), type of family ($p = 0.0058$), socioeconomic status ($p = 0.0000$), parental history of refractive error ($p = 0.000$), sibling history of refractive error ($p = 0.0003$), and type of lighting used for studying ($p = 0.0367$). Gender, type of school, religion, and dietary habits were not statistically significant. Conclusion & Recommendations: A notable proportion of middle school children in Rural Meerut have refractive error, predominantly myopia, influenced by several identifiable risk factors. Targeted vision screening programs are recommended for middle school children, especially those aged 11-13, from nuclear families, and with a family history of refractive error. Promoting adequate study lighting and addressing socioeconomic disparities are also crucial. Further research into specific dietary deficiencies is advised.***

Keywords: Refractive error, Myopia, Middle school children, Risk factors, Rural Meerut, Vision screening

1. Introduction

Eyes are the most valuable of our sense organs. They contribute enormously to one's learning capacities right from childhood. Great vision contributes incredibly to the quality of wellbeing and minds[1].

Many eye diseases originate in childhood and they may go unnoticed and can have negative impact on child's performance in the school and may also cause permanent damage to the eye in the later part of life. Vision screening in school going children should be done to detect refractive errors which is the correctable cause of decreased vision[1].

Refractive error, a prevalent visual impairment, represents a significant public health issue across various age groups. It encompasses a range of conditions where the eye does not focus light correctly onto the retina, resulting in blurred vision. Myopia, hypermetropia, astigmatism, and presbyopia are some common types of refractive error. While presbyopia generally affects older adults, the other types of refractive errors are common among children and adolescents, particularly during crucial developmental stages[2].

Middle school children, typically aged 11 to 14 years, are at a critical juncture in their visual development. This period often corresponds with rapid physical, cognitive, and emotional changes, which can significantly impact their visual health. Accurate diagnosis and management of refractive errors in this age group are essential, as these conditions can affect not only visual acuity but also academic performance, social interactions, and overall quality of life[3].

Aims and objectives

- To estimate the prevalence of refractive error in Public and Private middle school children in Rural Meerut.
- To identify the various risk factors associated with refractive error among the same study population.

2. Material and methods

Study design:

The present study was carried out in middle school children of Meerut district. The objective was to estimate the prevalence of refractive error in Public and Private middle school children in Rural Meerut and to identify the various risk factors associated with refractive error among the same study population.

Study period:

The study was carried out from April 2024 to March 2025 which was used for data collection, compilation and presentation of findings.

Study area:
The school-based study was conducted in selected schools of rural area of Meerut.

Study population:
The study population comprised of students in the selected schools of rural Meerut. Students from sixth to eighth standard was included in the study.

Inclusion criteria:
- Boys and girls of 6th to 8th standard in selected schools of rural Meerut.
- Those subjects whose parents have given informed consent.

Exclusion criteria:
- Absentees on the day of data collection.
- Those subjects where parents did not give consent.

Sample size estimation:
The sample size was calculated based on considering prevalence of refractive error of 17.4% from a study by Veer Singh et al[48]. Considering confidence interval of 95%, absolute precision of 5% .

Sample size was calculated by using the formula:
N =Design Effect * $Z^2_{1-\alpha/2}pq/d^2$
The final sample size obtained was 350.

Sampling method:
Multistage sampling method was used. There is a total of 12 blocks in Meerut district. In the first stage, one block was selected by simple random sampling method from 12 blocks. In second stage, two government schools and one private school from selected block was selected by simple random sampling method. Out of total sample size of 350, 175 participants were selected from both government and private school respectively. As number of participants were less than 175 in one government school therefore two government schools were selected to get desired sample size. During simple random sampling used in first two stages, lottery method was used for selection of desired block and schools respectively. In the third stage of sampling, students from sixth to eighth standard were selected proportionately using stratified random sampling method.

Study was done in the study area after obtaining approval from the Institute Ethics Committee **(No./SC-1/2025/2959)**. The collected data was entered for analysis in Microsoft Excel. Data analysis was done by Microsoft Excel and Epi-info software. Associations between qualitative variables were done using Chi square test. p-value of less than 0.05 has been considered to be significant.

3. Results

Prevalence of refractive error among participants:

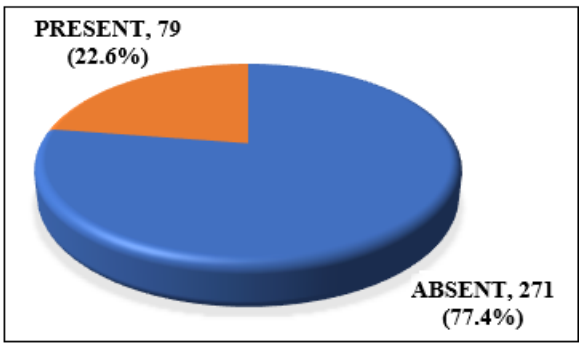

Figure 1: Prevalence of refractive error among study participants

Figure No. 1 demonstrates the prevalence of refractive error among the study participants. Out of total middle school children, 22.6% were found to have refractive error, while the remaining 77.4% had normal vision, showing that a notable proportion of the participants were affected by some form of refractive error.

Types of refractive error and study participants

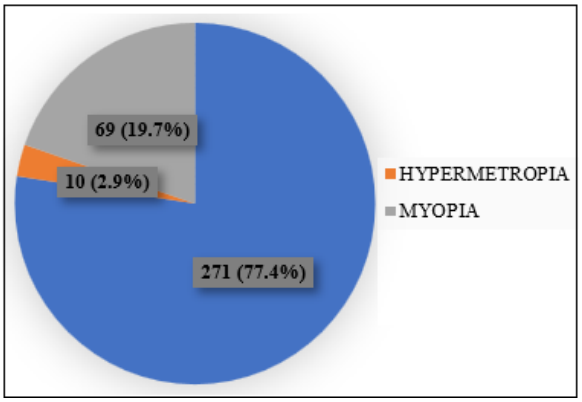

Figure 2: Type of refractive error among study participants

Figure No. 2 demonstrates the distribution of types of refractive error among the study participants. Among the total 350 participants, 19.7% were having myopia and only 2.9% were having hypermetropia and 77.4% were having normal vision.

Table 3: Factors affecting refractive error among study participants

	Refractive error		Total n (%)	Chi square value, df, p value
	Present n (%)	Absent n (%)		
Type of school				0.8, 1, 0.37
Government	36 (20.6)	139 (79.4)	175 (50)	
Private	43 (24.6)	132 (75.4)	175 (50)	
Age				4.469, 4, 0.0345
11	12 (26.1)	34 (73.9)	46 (13.1)	
12	18 (25)	54 (75)	72 (20.6)	
13	26 (27.4)	69 (72.6)	95 (27.2)	
14	13 (17.3)	62 (82.7)	75 (21.4)	
15	10 (16.1)	52 (83.9)	62 (17.7)	
Gender				1.319, 1, 0.25
Female	36 (25.7)	104 (74.3)	140 (40)	
Male	43 (20.5)	167 (79.5)	210 (60)	
Religion				0.123, 2, 0.7258
Hindu	40 (22.7)	136 (77.3)	176 (50.3)	
Muslim	38 (22.6)	130 (77.4)	168 (48.0)	
Others	1 (16.7)	5 (83.3)	6 (1.7)	
Type of family				7.597, 2, 0.0058
3-Generation	16 (20.5)	62 (79.5)	78 (22.3)	
Joint	21 (16)	110 (84)	131 (37.4)	
Nuclear	42 (29.8)	99 (70.2)	141 (40.3)	
Socio-economic status				22.896, 4, 0.0000
Class I	9 (60)	6 (40)	15 (4.3)	
Class II	24 (20)	96 (80)	120 (34.3)	
Class III	27 (19.9)	109 (80.1)	136 (38.8)	
Class IV	14 (19.7)	57 (80.3)	71 (20.3)	
Class V	5 (62.5)	3 (37.5)	8 (2.3)	
Parental history of refractive error				22.248, 3, 0.000
Father	15 (28.3)	38 (71.7)	53 (15.1)	
Mother	10 (40)	15 (60)	25 (7.1)	
Both	10 (58.8)	7 (41.2)	17 (4.9)	
None	44 (17.3)	211 (82.7)	255 (72.9)	
Sibling history of refractive error				12.817, 1, 0.0003
Yes	22 (41.5)	31 (58.5)	53 (15.1)	
No	57 (19.2)	240 (80.8)	297 (84.9)	
Type of lighting				4.363, 2, 0.0367
Electric bulb/electric lamp/led light	55 (21.3)	203 (78.7)	258 (73.7)	
Kerosene lamp/candle light	3 (60)	2 (40)	5 (1.4)	
Natural light	21 (24.1)	66 (75.9)	87 (24.9)	
Dietary habit				1.371, 1, 0.2416
Non- vegetarian	45 (20.5)	174 (79.5)	219 (62.6)	
Vegetarian	34 (25.9)	97 (74.1)	131 (37.4)	
Total	**79 (22.6)**	**271 (77.4)**	**350 (100)**	

Table No. 3 represents the distribution of refractive error among the study participants. Out of the total middle school children, 20.6% were found to have refractive error among government school students while the majority, 79.4% did not have any refractive error. In private schools, the prevalence of refractive error was slightly higher with 24.6% whereas 75.4% had normal vision. The chi-square value for the association between type of school (government or private) and refractive error was calculated to be 0.8 and p-value was 0.37, indicating that the observed difference in refractive error between government and private school students was not statistically significant at 5% significance level. This shows that the type of school attended did not have a significant impact on the prevalence of refractive error among the study participants. ($p > 0.05$)

Age-wise distribution of refractive error among the study participants shows that among the 46 participants aged 11 years, 26.1% were found to have refractive error. In the 12-year age group, comprising 72 participants, 25% were found to have refractive error. Among the 95 participants aged 13 years, 75 participants aged 14 years and 62 participants aged 15 years, refractive error was found to be 27.4%, 17.3% and 16.1% respectively. The chi-square value for the association between age and refractive error was calculated to be 4.469 and p-value was 0.0345, indicating that the observed difference in refractive error across different age groups was statistically significant at 5% significance level. This shows that age had a significant impact on the prevalence of refractive error among the study participants. ($p < 0.05$)

Among the 140 female participants, 25.7% were found to have refractive error while among the 210 male participants, 20.5% were found to have refractive error. The chi-square value for the association between gender and refractive error was calculated to be 1.319 and p-value was 0.25, indicating that the observed difference in refractive error between male and female participants was not statistically significant at 5% significance level. This shows that gender did not have a significant impact on the prevalence of refractive error among the study participants. ($p > 0.05$)

Religion wise distribution of refractive error among the study participants shows that among the 176 Hindu participants, 22.7% were found to have refractive error. Among the 168 Muslim participants, 22.6% were found to have refractive error and among the 6 participants belonging to other religions, 16.7% had refractive error. The chi-square value for the association between religion and refractive error was calculated to be 0.123 and p-value was 0.7258, indicating that the observed difference in refractive error among participants of different religions was not statistically significant at 5% significance level. This shows that religion did not have a significant impact on the prevalence of refractive error among the study participants. ($p > 0.05$)

Among the 78 participants belonging to three-generation families, 20.5% were found to have refractive error. Among the 131 participants from joint families, 16% had refractive error while among the 141 participants from nuclear families, 29.8% were found to have refractive error. The chi-square value for the association between type of family and refractive error was calculated to be 7.597 and p-value was 0.0058, indicating that the observed difference in refractive error among participants from different family types was statistically significant at 5% significance level. This shows that type of family had a significant impact on the prevalence of refractive error among the study participants. ($p < 0.05$)

Distribution of refractive error among study participants according to their socio-economic status shows that among the 15 participants belonging to Class I, 60% were found to have refractive error. Among the 120 participants in Class II, 20% were found to have refractive error. In Class III, consisting of 136 participants, Class IV consisting of 71 participants and Class V consisting of 8 participants 19.9% , 19.7% and 62.5% respectively had refractive error. The chi-square value for the association between socio-economic status and refractive error was calculated to be 22.896 and p-value was 0.0000, indicating that the observed difference in refractive error across different socio-economic classes was statistically significant at 5% significance level. This shows that socio-economic status had a significant impact on the prevalence of refractive error among the study participants. ($p < 0.05$)

Among the 53 participants who reported a history of refractive error in their father, 28.3% were found to have refractive error. Among the 25 participants whose mother had a history of refractive error, 40% were found to have refractive error. Out of the 17 participants who reported a positive history of refractive error in both parents, 58.8% were found to have refractive error. In contrast, among the 255 participants who reported no parental history of refractive error, only 17.3% were found to have refractive error. The chi-square value for the association between parental history of refractive error and refractive error in participants was calculated to be 22.248, with a p-value of 0.000, indicating that the observed difference was statistically significant at 5% significance level. This confirms that a positive parental history of refractive error had a significant impact on the prevalence of refractive error among the study participants. ($p < 0.05$)

Among the 53 participants who reported a positive history of refractive error in their siblings, 41.5% were found to have refractive error. In contrast, among the 297 participants who reported no sibling history of refractive error, 19.2% were found to have refractive error. The chi-square value for the association between sibling history of refractive error and refractive error in participants was calculated to be 12.817, with a p-value of 0.0003, indicating that the observed difference was statistically significant at 5% significance level. This confirms that a positive sibling history of refractive error had a significant impact on the prevalence of refractive error among the study participants. ($p < 0.05$)

Among the 258 participants who studied under electric bulbs, electric lamps, or LED lights, 21.3% were found to have refractive error. Among the 5 participants who studied under kerosene lamps or candlelight, 60% were found to have refractive error. Among the 87 participants who relied on natural light while studying, 24.1% were found to have refractive error. The chi-square value for the association between type of lighting used while studying and refractive error was calculated to be 4.363, with a p-value of 0.0367, indicating that the observed difference in refractive error across different lighting types was statistically significant at 5% significance level. This shows that the type of lighting used while studying had a significant impact on the prevalence of refractive error among the study participants, with the highest prevalence observed among those studying under kerosene lamps or candlelight. ($p < 0.05$)

Distribution of refractive error among study participants according to their dietary habit shows that among the 219 participants who followed a non-vegetarian diet, 20.5% were found to have refractive error while among the 131 participants who followed a vegetarian diet, 25.9% were found to have refractive error. The chi-square value for the association between dietary habit and refractive error was calculated to be 1.371, with a p-value of 0.2416, indicating that the observed difference in refractive error between vegetarian and non-vegetarian participants was not statistically significant at 5% significance level. This shows that dietary habit did not have a significant impact on the prevalence of refractive error among the study participants. ($p > 0.05$).

4. Discussion

The current study is a school based cross sectional study conducted to estimate the prevalence of refractive error and its associated factors among middle school children. Present study depicts the prevalence of refractive error among participants which was 22.6%. This finding is comparable to the study by Soni et al. (2020) in Delhi who found a slightly

lower prevalence of 20.3% [4] . Patil et al. (2021) in Mumbai observed a higher rate of 28.6% [5]. The differences across studies may be attributed to regional variations in screen exposure, academic load, and outdoor activity. The 22.6% prevalence in the current study underlines the importance of early screening programs to identify correctable vision issues among children. In the type-wise distribution of refractive errors among participants. Myopia accounted for 19.7%, hypermetropia 2.9%, while 77.4% had no refractive error. This pattern is consistent with findings by Sharma et al. (2019) in Jammu, where myopia was reported in 18.4% and hypermetropia in 5.1% of children [6]. Similarly, Soni et al. (2020) in Delhi noted 17.6% myopia and 2.7% hypermetropia among school students [4]. In contrast, Banerjee et al. (2021) in West Bengal found a higher myopia rate of 25.2%, possibly due to greater near-work exposure in their setting [7]. The predominance of myopia in the present study aligns with the global trend of increasing myopia in school-age children, likely driven by reduced outdoor time and increased digital device use during study hours. Present study compares the prevalence of refractive error between government and private school students. Refractive error was present in 20.6% of government schoolchildren and 24.6% of private schoolchildren. Although the proportion was slightly higher in private schools, the difference was not statistically significant ($p = 0.37$). Similar findings were reported by Kamath et al. (2021), where 21% of government schoolchildren and 25% of private schoolchildren had refractive error, with no significant association [8]. In contrast, Sharma et al. (2019) in Jammu found a more pronounced difference i.e. 27.5% in private schools versus 17.3% in government schools suggesting that regional and academic factors may influence this variation[6]. Present study explores the association between age and refractive error. The highest prevalence was seen at age 13 (27.4%), followed closely by ages 11 (26.1%) and 12 (25%). The lowest prevalence was observed at age 15 (16.1%). The association between age and refractive error was found to be statistically significant ($p = 0.0345$). Similar trends were reported by Patil et al. (2021), where the prevalence peaked at age 13 (28%) and declined by age 15 (21%) [5]. Yadav et al. (2021) also observed the highest prevalence between 12-13 years, accounting for 26.4% and 27.8% respectively, suggesting increased visual stress during middle school years [9]. The significant association in the current study supports the need for targeted screening in early adolescence. Current study shows the distribution of refractive error by gender. The prevalence was higher among females (25.7%) compared to males (20.5%), but the difference was not statistically significant ($p = 0.25$). A similar gender pattern was observed by Sharma et al. (2019), who reported 26.8% prevalence in females and 21.4% in males in Jammu [6]. The slightly higher prevalence in females across multiple studies, including the present one, may be attributed to less parental care for girls or poor nutrition or less outdoor activities, but the lack of statistical significance suggests gender alone may not be a strong determinant. Among the distribution of refractive error across religious groups. Refractive error was present in 22.7% of Hindu, 22.6% of Muslim, and 16.7% of children from other religious backgrounds. The association between religion and refractive error was not statistically significant ($p = 0.7258$). Similar findings were reported by Gupta et al. (2021), who observed nearly equal prevalence among Hindu (23.1%) and Muslim (22.5%) children in Haryana [10]. These findings suggest that religion does not appear to influence refractive error prevalence and likely reflects the local demographic distribution rather than a risk factor. Present study shows that the prevalence of refractive error was highest among children from nuclear families (29.8%), followed by three-generation families (20.5%) and joint families (16%). This association was found to be statistically significant ($p = 0.0058$). Kaur et al. (2020) reported a similar pattern in Amritsar, with refractive error prevalence of 31% in nuclear families compared to 18% in joint families [11]. Reddy et al. (2021) in Hyderabad observed 28% prevalence in nuclear and 16.5% in joint families, attributing the difference to reduced outdoor interaction and increased screen time in nuclear settings [12]. The present findings support previous evidence suggesting that family structure may influence lifestyle habits and supervision, thereby impacting visual health in children. Present study demonstrates the association between socio-economic status and refractive error. The highest prevalence was noted in Class I (60%) and Class V (62.5%), while Classes II, III, and IV had relatively lower prevalence ranging from 19.7% to 20%. The association was found to be statistically significant ($p = 0.0000$). A similar pattern was observed by Rao et al. (2021), who reported higher refractive error in both upper (52%) and lower (48%) socio-economic groups compared to the middle class (35%) in Bengaluru [13]. The findings of the present study highlight that both ends of the socio-economic spectrum may carry distinct risk profiles for visual health. Current study demonstrates a statistically significant association between parental history of refractive error and its occurrence in children ($p = 0.000$). The prevalence was highest among children with a history in both parents (58.8%), followed by those with only maternal (40%) or paternal history (28.3%). Children with no parental history had the lowest prevalence (17.3%). Similar findings were reported by Gupta et al. (2021), who observed 54% prevalence in children with both parents affected, 35% with maternal history, and 27% with paternal history [10]. Yadav et al. (2021) in Dehradun found a prevalence of 42% among children with parental history, compared to 19% without parental history [9]. The present study reinforces the well-established role of heredity in refractive error development and highlights the importance of family eye health history in screening strategies. Present study shows a significant association between sibling history of refractive error and its presence in the child ($p = 0.0003$). Among children with a positive sibling history, 41.5% had refractive error, compared to only 19.2% among those without such history. Kaur et al. (2020) noted a prevalence of 37.5% in children with sibling history, attributing it to shared genetic and environmental influences [11]. The findings in the present study highlight the importance of including sibling history as part of early vision screening, especially in school health programs. Present study shows a statistically significant association between type of lighting used while studying and refractive error ($p = 0.0367$). Children using kerosene lamps or candles had the highest prevalence (60%), followed by those studying under natural light (24.1%) and electric/LED lighting (21.3%). Das et al. (2021) in Odisha similarly found increased prevalence of refractive error among students relying on kerosene or candle light, citing inadequate brightness and flicker related eye strain as possible causes [14]. Yadav et al. (2021) also reported a higher prevalence (26%) among those using natural light

compared to 20% with consistent electric lighting, especially during evening hours [15]. The present findings align with these studies, suggesting that poor or inconsistent lighting, whether due to dim sources or fluctuating natural conditions may increase visual fatigue. Current study explores the association between dietary habit and refractive error. The prevalence was slightly higher among vegetarian children (25.9%) compared to non-vegetarian children (20.5%), but this difference was not statistically significant (p = 0.2416). Verma et al. (2020) found a small difference i.e. 24% in vegetarians versus 20% in non-vegetarians [16]. These similarities suggest that dietary pattern alone may not be a major determinant of refractive error unless linked with deficiencies in key micronutrients like vitamin A, omega-3 fatty acids, or antioxidants. On the other hand, Das et al. (2021) in Odisha reported a more distinct difference i.e. 31% among vegetarians versus 18% among non-vegetarians which they attributed to limited dietary diversity and lower intake of protective nutrients among vegetarian children in rural areas [14]. This variation could arise from regional dietary practices and socioeconomic factors affecting food quality and nutritional balance. Thus, while the current study shows a trend toward higher refractive error among vegetarians, it aligns with other research suggesting that the association is complex and influenced by overall nutritional adequacy rather than diet type alone.

5. Conclusion

This study found a 22.6% prevalence of refractive error among middle school children in Rural Meerut, with myopia being the most common type. Age, family type, socioeconomic status, parental and sibling history of refractive error, and type of lighting used for studying were identified as significant risk factors. Gender, type of school, religion, and dietary habits did not show a statistically significant association.

6. Recommendations

Implement targeted vision screening programs for middle school children, especially focusing on those aged 11-13, from nuclear families, and with a family history of refractive error. Promote adequate lighting for studying and address socioeconomic disparities that may contribute to visual health issues. Further research into specific dietary deficiencies is also recommended.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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