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"A COMPARATIVE STUDY OF STEREO ACUITY, AMPLITUDE OF ACCOMMODATION, AND REFRACTIVE STATE IN SCHOOL-GOING CHILDREN (6-12 YEARS) FROM URBAN AND RURAL PUNE"

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Abstract

Children's visual development is influenced by a multitude of environmental and lifestyle factors, underscoring the importance of understanding disparities in visual characteristics between urban and rural settings. This study sought to compare stereo acuity, amplitude of accommodation, and refractive status in school-aged children (6-12 years) from urban and rural areas in Pune district. A total of 900 school children from both urban and rural schools were systematically selected for evaluation. Measurements included stereo acuity using the Titmus stereo test, amplitude of accommodation using the RAF rule, and refractive status with full spectacle correction. Statistical analysis, including descriptive statistics and chi-square tests, was employed. The demographic study encompassed participants from 7 Taluka schools, with the highest number hailing from Maval Taluka. Significant differences in stereo acuity and amplitude of accommodation were noted between urban and rural children. Interestingly, stereoacuity was notably lower compared to refractive errors and amplitude of accommodation. This discrepancy in stereo acuity highlights potential environmental influences on visual development, suggesting the need for early detection and management of visual issues. Recognizing these variations can inform the implementation of targeted public health initiatives and vision care strategies tailored to the specific needs of urban and rural populations, ultimately enhancing academic performance and overall well-being among children.

Keywords - Refractive errors, Amplitude of Accommodation, stereo acuity, urban, rural.

1. Introduction

Children's visual development is a complex process that is influenced by a number of variables, including their environment, their lifestyle, and their heredity. (Powell C *et al* ., (2005)) During a child's formative years, the acquisition and enhancement of visual skills hold exceptional significance, influencing not just their academic achievements but also their holistic well-being. One of the factors that can potentially affect visual development is the geographical context in which a child grows up, whether it be in an urban or rural setting (Metsing TI *et al.,* (2008)) (Moodley VR et al., (2008))

Uncorrected refractive defects are one of many variables that contribute to the improper development of stereopsis.(Sethi S *et al.,* (2015)) Stereopsis is negatively impacted by all forms of refractive defects because as it leads to visual blur, that decreases the binocular function and sensory fusion. Stereoacuity is the clinical measurement of stereoscopic threshold that is obtained from the minimum disparity that results in the appreciation of depth and it is an indicator of binocularity. (Kulp MT et al ., (2014)) Accommodative anomalies are disorders of the eye's focussing mechanism that result in an inappropriate response to a particular visual demand and are classified into accommodative insufficiency (AI), accommodative excess (AE) and accommodative infacility (AIF). (Garzia R.., (2006)) (Trachimowicz R,, *et al (*2000)) Near point vergence anomalies are disorders of binocular vision that cause an inability to sustain comfortable bifoveal fixation5 and include convergence insufficiency (CI), convergence excess (CE) and fusional vergence dysfunction (FVD).(Campos EC *et al.,* (1980))

The differences between urban and rural surroundings include a range of living situations, resource accessibility, and lifestyle choices, all of which may have an impact on a child's eye health. (Fricke TR.,*et al* (1997))Higher population densities, more exposure to digital screens, and easier access to medical facilities are frequently attributes of urban settings. On the other hand, rural areas could have lower population densities, less accessibility to high-quality medical care, and unique visual stimuli related to outdoor activities and agricultural practises. (Tidbury LP., *et al* (2018))For several reasons, it is crucial to comprehend the differences in visual qualities between urban and rural settings. First, it enables the identification of certain visual obstacles that kids may encounter in various contexts. (Ip JM,et al (2008)) Second, it offers perceptions on how lifestyle and environmental influences may affect the visual profiles of young people. The development of personalised public health interventions and vision care

strategies that address the requirements of children in these many situations would be impossible without this understanding, which brings us to our final point. (Iqbal S., *et al* (2013))

This cross-sectional study aims to explore and contrast important aspects of visual health in school-age children between the ages of 6 and 12 who live in both urban and rural parts of the Pune district. Our focus is on measuring stereo acuity, accommodation amplitude, and refractive status because they provide an extensive amount of information about a child's visual ability. We seek to provide a thorough understanding of the differences between children's visual profiles in urban and rural areas by methodically examining these visual characteristics. Additionally, regardless of where school-age children are raised, this research aims to provide useful information for the creation of customised vision care programmes that will promote good visual health.

2. Materials and methods

Study area

The Ethics Committee granted permission for the study's execution. Ethical clearance was taken from DR D Y Patil Vidyapeeth Ethical Committee; Ref no: DYPV/EC/289/2019 Dated 6th June 2019. The 900 students.

Participants

This cross-sectional study aimed to investigate and compare critical aspects of visual health in school-going children aged 6 to 12 years from urban and rural areas within the Pune district.

In our cross-sectional study conducted in the school of western Maharashtra, Pune District. In this study out of 14 talukas of Pune district, 3 urban and 4 rural areas are selected as per sampling convenience. Total of 900 children’s out of which 450 in each area (urban and rural). In this study out of 14 Taluka 7 taluka were selected for the study as per convenience. The children within 6 to 12 years of age were included in this study. Childrens with any active ocular pathology, co morbidity and any additional disability other than visual impairment were excluded from the study.

Data collection

Eye Checking protocol

Data was gathered from the schools during school hours. Due to the portable nature of all the equipment employed, all procedures were carried out at the school. and each school supplied its own testing space premises. There were four stations in the testing area, one where the history of concerns by the participant. There was a possibility that visual issues were obtained, and three where amplitude, visual acuity examining of accommodations and NPC, respectively. Every student began at the history station. where there were significant complaints that were recorded accompanied by his or her record card.

Stereo acuity was measured using Titmus stereo test, amplitude of accommodation was quantified using near point rule such as RAF rule, and refractive status was determined were given the full spectacle correction. Amplitude of accommodation was measured binocularly using the 'push-up' method. The necessary equipment: a near-point target (such as a reading card or accommodative target chart), an occluder (such as an eye patch), and a ruler or measuring device were arranged.

Analysis

All the data will be entered in micro soft excel. Data entry and analysis was used Statistical Package for the Social Sciences (SPSS) version 25.0.

3. Results

- **Group 1 (Urban Area):**

In the urban area, children exhibited slightly younger ages on average, with a mean age of 8.38 years. There was a relatively balanced gender distribution, with 39.6% of the children being female. Urban children tended to have taller stature and higher body weight compared to their rural counterparts, indicating potential differences in nutrition and lifestyle factors. Their mean BMI was 17.93, suggesting a healthy weight range overall. While their near point of accommodation (NPA) was similar to rural children, they demonstrated a significantly higher near point of convergence (NPC), implying possible differences in visual convergence abilities. Interestingly, despite these differences, their stereopsis values were comparable to those of rural children, suggesting similar levels of binocular vision development. (Table1)

- **Group 2 (Rural Area):**

Children from rural areas, on the other hand, presented slightly older ages on average, with a mean age of 8.88 years. A higher proportion of females (45.6%) was observed in this group compared to the urban area. Despite being older, rural children tended to have shorter stature and lower body weight, potentially indicative of different environmental and socioeconomic

conditions. Their mean BMI was 16.23, which, while still within a healthy range, was slightly lower than that of urban children. Notably, rural children exhibited a significantly lower near point of convergence (NPC), suggesting potential differences in oculomotor control. However, their stereopsis values were similar to those of urban children, indicating comparable levels of binocular vision development despite these differences in near vision parameters.(Table 1)

- **Group 1 (Urban Area):**

In the urban area, the prevalence of myopia was notably higher, with 94.8% of children diagnosed with this refractive error. This suggests a significant prevalence of nearsightedness among urban children, which could be influenced by factors such as increased near work activities, longer periods of screen time, or environmental factors associated with urban living. Conversely, only a small proportion (5.2%) of children were diagnosed with hypermetropia, indicating a relatively lower prevalence of farsightedness in this population. This disparity in refractive errors underscores the potential impact of urban environmental factors on visual health and highlights the importance of early detection and management of myopia in urban children to prevent potential vision-related complications. (Table1) (Figure 1)

- **Group 2 (Rural Area):**

In contrast, the prevalence of myopia in the rural area was lower compared to the urban area, with 70.7% of children diagnosed with this refractive error. This suggests a lower prevalence of myopia among rural children, which could be influenced by differences in lifestyle factors, such as less near work and increased outdoor activities. Conversely, a higher proportion (29.3%) of rural children were diagnosed with hypermetropia, indicating a greater prevalence of farsightedness in this population. This difference in refractive errors between urban and rural areas highlights the potential influence of environmental and lifestyle factors on visual health outcomes and emphasizes the need for tailored vision care strategies to address the specific needs of children in rural communities. (Table 1) (Figure 2)

- **Group 1 (Urban Area):**

Urban areas, represented by talukas such as Haveli and Pune City, exhibited higher numbers of participants, with 86 and 84 children, respectively. In these urban regions, there were no rural participants, indicating a complete absence of rural representation in the study sample. Despite variations across different talukas within urban areas, the overall urban participation remained consistent at 450 children. The statistical analysis did not reveal any significant differences in

participation between the urban and rural groups across all talukas, as indicated by the non-significant p-values. (Table 3)

- **Group 2 (Rural Area):**

Rural areas, represented by talukas such as Beed, Khed, Maval, Mulshi, and Velhe, demonstrated diverse participation, with varying numbers of participants ranging from 82 to 99 children across different talukas. These regions collectively accounted for 450 children in the study sample. Interestingly, certain talukas, such as Maval and Mulshi, exhibited higher rural participation compared to urban areas. However, the overall rural participation remained consistent at 450 children. The statistical analysis did not reveal any significant differences in participation between the urban and rural groups across all talukas, as indicated by the non-significant p-values. (Table 3)

These descriptive statistics shed light on various visual parameters among children, delineating differences between Group 1 (urban area) and Group 2 (rural area):

Group 1 (Urban Area):

In the urban area, children exhibited comparable near refraction accommodation (NRA) and positive refraction accommodation (PRA) to their rural counterparts. The mean NRA was 8.93 cm, and the mean PRA was 7.63 cm, indicating similar near and distant focusing abilities among urban children. Stereopsis values also aligned closely with those of rural children, with a mean of 0.28 logmar, suggesting consistent depth perception abilities based on binocular vision. However, urban children showed a slightly more myopic trend in spectacle prescription (Spectacle RX), with a mean of -0.46 diopters, indicating a higher prevalence of near sightedness in this group compared to rural children.(Table 4)

Group 2 (Rural Area):

In contrast, rural children displayed comparable visual parameters to their urban counterparts, with mean NRA and PRA values of 8.93 cm and 7.63 cm, respectively. Their stereopsis values were also consistent, with a mean of 0.28 logmar, indicating similar depth perception abilities based on binocular vision. However, rural children exhibited a slightly less myopic trend in spectacle prescription (Spectacle RX), with a mean of -0.46 diopters, suggesting a lower prevalence of nearsightedness compared to urban children. These findings imply that while certain visual parameters may vary between urban and rural contexts, overall visual characteristics remain relatively consistent across both groups. (Table 4)

- **Group 1 (Urban Area):**

In the urban area, the prevalence of certain types of refractive errors varied. Compound myopic astigmatism was more prevalent, affecting 49 individuals, compared to 26 in the rural

area. Myopia was also more common in urban children, with 51 individuals affected, indicating a higher prevalence of nearsightedness. Additionally, compound hypermetropic astigmatism was observed in 20 individuals, statistically significantly higher than in rural children. Hyperopia and myopic astigmatism were relatively less prevalent, affecting 4 and 18 individuals, respectively, with statistically non-significant differences compared to rural areas. Mixed astigmatism was rare, affecting only 2 individuals in the urban area. (Table5) (Figure 2)

- **Group 2 (Rural Area):**

In contrast, the rural area exhibited different patterns of refractive errors. Myopia was the most prevalent, affecting 92 individuals, indicating a higher prevalence of nearsightedness compared to urban children. Compound myopic astigmatism was also observed in 26 individuals, though less prevalent than in urban areas. Myopic astigmatism affected 29 individuals, while compound hypermetropic astigmatism affected 24 individuals, both showing statistically non-significant differences compared to urban areas. Hyperopia and mixed astigmatism were relatively rare, affecting only 2 individuals each in the rural area. (Table5) (Figure 2)

- **Group 1 (Urban Area):**

In the urban area, binocular assessments revealed differences in certain parameters compared to rural areas. Near point of convergence (NPC) was observed to be affected in 12 individuals, significantly lower than in rural children. Heterophoria (near) affected 20 individuals, while negative fusional vergence and positive fusional vergence affected 5 and 12 individuals, respectively. These findings suggest a potential difference in binocular vision and eye coordination among urban children, with a lower prevalence of NPC abnormalities compared to rural counterparts. (Table 6) (Figure 3)

- **Group 2 (Rural Area):**

Conversely, rural children exhibited different patterns of binocular assessment parameters. Near point of convergence (NPC) was affected in 22 individuals, significantly higher than in urban children. Heterophoria (near) affected 32 individuals, indicating a higher prevalence of near vision misalignment in rural areas. Negative fusional vergence and positive fusional vergence affected 10 and 20 individuals, respectively. These results suggest potential differences in binocular vision and eye coordination among rural children, with a higher prevalence of NPC abnormalities compared to urban counterparts. (Table 6) (Figure 3)

- **Group 1 (Urban Area):**

In the urban area, the amplitude of accommodation (AA) was affected in 78 individuals, which was significantly lower compared to rural children. Accommodative facility (AF) with ±2 lens was observed in 100 individuals, while AF of the right eye was present in 105 individuals. Negative relative accommodation (NRA) and positive relative accommodation (PRA) affected 25 and 29 individuals, respectively. These findings suggest potential differences in accommodative abilities among urban children, with a lower prevalence of AA abnormalities compared to rural counterparts. (Table 7) (Figure 4)

- **Group 2 (Rural Area):**

Conversely, rural children exhibited different patterns of accommodative parameters. The amplitude of accommodation (AA) was affected in 95 individuals, significantly higher than in urban children. Accommodative facility (AF) with ±2 lens was observed in 110 individuals, while AF of the right eye was present in 128 individuals. Negative relative accommodation (NRA) and positive relative accommodation (PRA) affected 34 and 32 individuals, respectively. These results suggest potential differences in accommodative abilities among rural children, with a higher prevalence of AA abnormalities compared to urban counterparts. (Table 7) (Figure 4)

Figure 1 Percentage of children suffering from diseases in urban and rural area

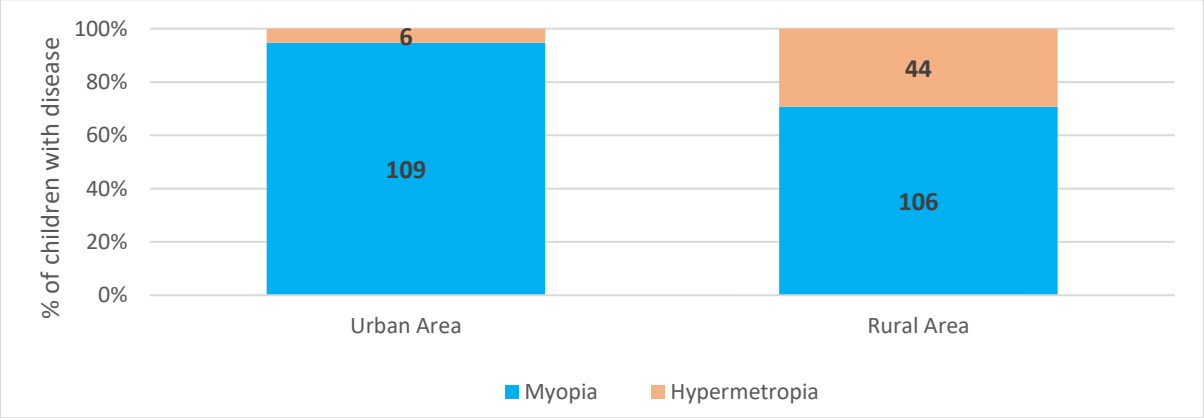

Figure 2 Refractive errors in both eyes of the children's based on geographical area

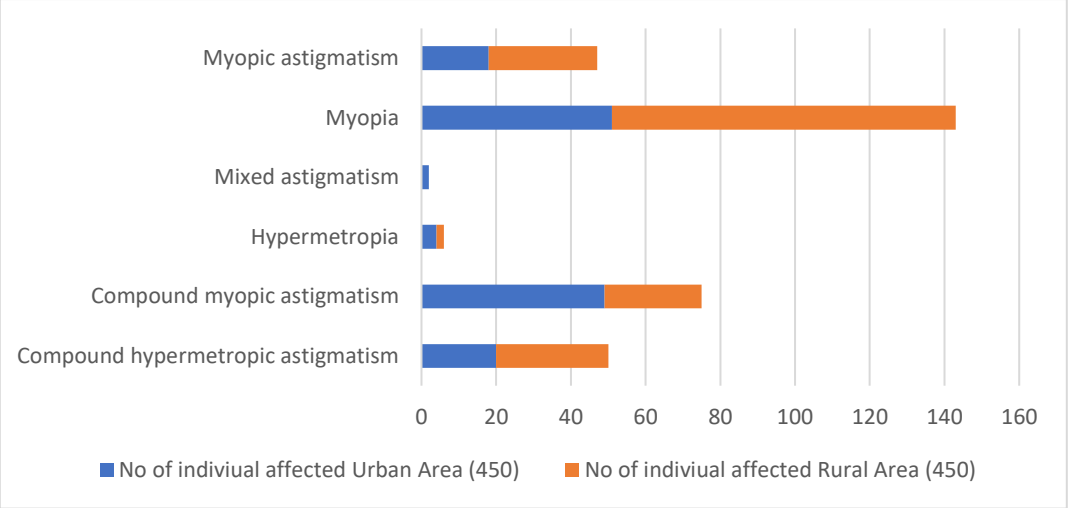

Figure 3 Binocular Assessment in both eyes of the individual based on geographical area

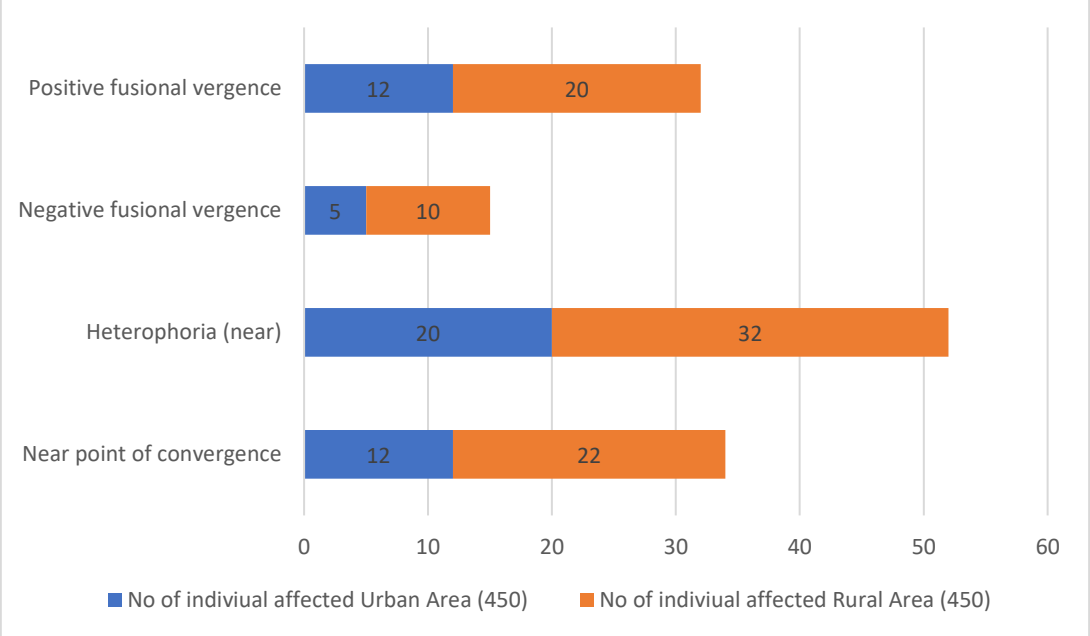

Figure 4 - Amplitude of Accommodation in both eyes of the individual based on geographical area

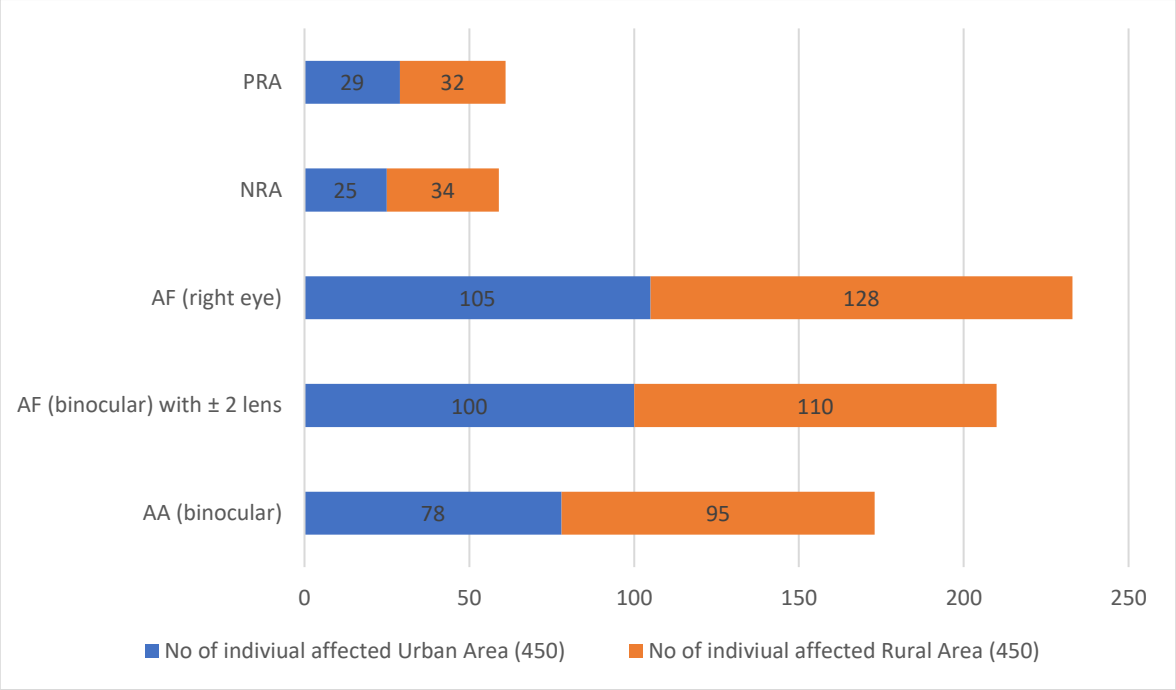

Table 1 Demographic study

Characteristics	Urban Area (450)	Rural Area (450)	P-Value
Age	8.38 ± 1.7	8.88 ± 1.50	
Female; N (%)	178 (39.6%)	205 (45.6%)	
Height	151.19 ± 6.49	140.10 ± 12.19	
Weight	41.03 ± 9.48	33.30 ± 18.89	
B.M.I.	17.93 ± 3.66	16.23 ± 3.39	
NPA (in cm)	8.91 ± 2.46	8.95 ± 2.43	0.928
NPC (in cm)	8.37 ± 2.46	7.74 ± 2.19	< 0.001*
Stereopsis (inlogmar)	0.28 ± 0.27	0.28 ± 0.26	0.948

*Values displayed are mean ± SD, test used: Mann-Whiteney U test. P-value < 0.05; statistically significant represented by **

Table 2 - Type of Refractive Error

Type of Refractive Error	Urban Area (115)	Rural Area (150)	P-Value
Myopia (215)	109 (94.8%)	106 (70.7%)	< 0.001*
Hypermetropia (50)	6 (5.2%)	44 (29.3%)	

Table 3 Study of Taluka distribution based on geographical area.

Taluka	Group	Total	P value

	Urban	**Rural**		
Beed	51	82	133	0.718
Haveli	86	0	86	
Khed	51	82	133	
Maval	62	99	161	
Mulshi	58	93	151	
Pune City	84	0	84	
Velhe	57	94	151	
Total	450	450	900	

Table 4 Descriptive study of Visual parameters in children's

Parameters	**N**	**Minimum**	**Maximum**	**Mean**	**SD**
NRA (in cm)	900	6	24	8.93	2.42
PRA (in cm)	900	5	24	7.63	2.26
Stereopsis (inlogmar)	900	0.22	1.82	0.28	0.27
Spectacle RX	900	-4	3.5	-0.46	1

Table 5 Refractive errors in both eyes of the children's based on geographical area

Types of Refractive errors	**No of individual affected**		**Statistical significance**
	Urban Area (450)	**Rural Area (450)**	
Compound hypermetropic astigmatism	20	24	0.042
Compound myopic astigmatism	49	26	
Hyperopia	4	2	
Mixed astigmatism	2	0	
Myopia	51	92	
Myopic astigmatism	18	29	

Table 6 Binocular Assessment in both eyes of the individual based on geographical area

Binocular Assessment	No of individual affected		Statistical significance
	Urban Area (450)	Rural Area (450)	
Near point of convergence	12	22	0.017
Heterophoria (near)	20	32	
Negative fusional vergence	5	10	
Positive fusional vergence	12	20	

Table 7 - Amplitude of Accommodation in both eyes of the individual based on geographical area

Accommodation	No of individual affected		Statistical significance
	Urban Area (450)	Rural Area (450)	
AA (binocular)	78	95	0.022
AF (binocular) with ± 2 lens	100	110	
AF (right eye)	105	128	
NRA	25	34	
PRA	29	32	

AA, amplitude of accommodation; AF, accommodative facility; NRA - negative relative accommodation; PRA - positive relative accommodation.

4. Discussion

Group A:

In Group A, which represents the urban area, a strikingly high prevalence of myopia was observed, with 94.8% of affected children falling into this category. Conversely, the prevalence of hypermetropia was notably lower, with only 5.2% of children affected. These findings suggest a potential trend towards myopia in urban populations, possibly influenced by factors such as increased near work activities or prolonged screen time. Moreover, the descriptive study of visual parameters indicated differences in accommodative abilities, with AF (binocular) with ± 2 lens being higher in urban populations. However, despite these differences, the levels of stereoacuity and accommodative abnormalities were not significantly different between urban and rural areas in this group.

Group B:

In Group B, representing the rural area, the prevalence of myopia was lower compared to urban areas, with 70.7% of affected children falling into this category. Hypermetropia, on the other hand, showed a higher prevalence of 29.3% in rural populations. This suggests potential differences in the distribution of refractive errors between urban and rural populations, possibly influenced by environmental factors or access to eye care services. Additionally, the descriptive

study of visual parameters indicated higher levels of heterophoria in rural areas, possibly due to limited access to eye care services or other socioeconomic factors. Furthermore, accommodative abilities, as indicated by AA and AF, showed variations between urban and rural populations, with AA (binocular) being more prevalent in rural areas.

Combined Discussion:

The combined analysis of both groups highlights significant differences in the prevalence of refractive errors and visual parameters between urban and rural populations. While urban areas exhibit a higher prevalence of myopia and lower prevalence of hypermetropia, rural areas show the opposite trend. Additionally, differences in accommodative abilities and heterophoria levels suggest potential disparities in access to eye care services and lifestyle factors between urban and rural populations. These findings underscore the importance of targeted public health interventions and increased access to eye care services, particularly in rural areas, to address the disparities in visual health outcomes. Moreover, the impact of environmental conditions, socioeconomic factors, and educational resources on visual health cannot be understated, emphasizing the need for comprehensive and inclusive approaches to vision care.

5 Conclusion

This study focused on measuring stereo acuity, accommodation amplitude, and refractive status in an effort to identify potential differences and factors affecting visual development in these two different environments. The main finding observed is that stereoacuity was considerably lower in cases than the refractive errors & Amplitude of Accommodation. The study revealed significant differences in stereo acuity between urban and rural children. These variations suggest the potential influence of environmental factors and lifestyle patterns on stereo vision. The Amplitude of Accommodation study with respect to urban & rural population had not much varied difference in result and the findings emphasize the complex interplay of near work activities and outdoor experiences in shaping accommodation capacity. Analysis of refractive status demonstrated variations between urban and rural children. Factors such as lifestyle, access to healthcare, and environmental influences play a crucial role in shaping the visual characteristics of young individuals. Early detection and management of visual issues are vital for enhancing academic performance and overall well-being in these young populations.

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