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HEALTH AND REHABILITATION

EVALUATION OF AGE-RELATED VISUAL FIELD CHANGES WITH DIFFERENT REFRACTIVE ERRORS

Original Research

Sobia Yousif*[1], Prof Dr. Rashida Perveen[1], Ayesha Saleem[2], Iqra Manzoor[1], Rabia Akram[1], Hamna Ahmad[1], Aleeza Naeem[1], Ghashia Gul[3]
[1]Department of Allied Health Sciences, Superior University, Lahore
[2]College of Ophthalmology & Allied Vision Sciences, King Edward Medical University Lahore
[3]Optometrist, Superior University Lahore

Corresponding Author: Sobia Yousif, Department of Allied Health Sciences, Superior University, Lahore, Sobiayousif390@gmail.com
Acknowledgement: The authors express gratitude to all study participants and the research team for their valuable contributions to this study.

Conflict of Interest: None | Grant Support & Financial Support: None | Publication Date: 12-02-2025

ABSTRACT

Background: Visual field sensitivity variations associated with refractive errors in young adults remain inadequately characterized, particularly in relation to aging and regional differences. While previous studies have focused on elderly populations, limited data exist on how myopia, hyperopia, and astigmatism affect visual field sensitivity in individuals aged 18 to 30 years. Understanding these variations is crucial for refining clinical assessment strategies and optimizing refractive error management to ensure optimal visual function.

Objective: To evaluate visual field sensitivity patterns in young adults with different refractive errors and assess the relationship between age, refractive status, and regional variations in visual field sensitivity.

Methods: A cross-sectional study was conducted on 58 participants, including 26 myopic, 2 hyperopic, and 30 astigmatic individuals aged 18–30 years. Participants underwent refractive assessment using an auto-refractometer, followed by subjective refraction with a trial frame. Visual acuity was measured using the Snellen chart, and visual field sensitivity was analyzed using Humphrey perimetry. Sensitivity deviations were recorded for the superior, inferior, nasal, and temporal quadrants in both eyes, with and without refractive correction.

Results: In myopic individuals, the superior field remained stable (-0.25 to -3.75 D), while the inferior field showed age-related declines (-0.3 dB at -1.75 D, -0.5 dB at -3.25 D, -0.75 dB at -2.0 D). Nasal deviations ranged from -0.05 dB to -1.25 dB, with temporal sensitivity declining by -0.5 dB at -4.0 D in non-corrected individuals. Hyperopic participants exhibited increased sensitivity in the superior (+1.5 to +2.6 dB), inferior (+2.0 dB), nasal (+1.0 to +1.5 dB), and temporal (+2.0 to +3.0 dB) fields. Astigmatism showed no superior field changes but demonstrated nasal deviations (-0.7 to -1.0 dB) and temporal reductions (-0.09 to -0.7 dB) in the right eye. The left eye exhibited inferior (-0.4 to -1.0 dB), nasal (-0.2 to -1.0 dB), and temporal (-0.3 to -1.0 dB) deviations.

Conclusion: Visual field sensitivity in young adults varies significantly based on refractive error type and correction status. Myopia exhibited age-related declines, hyperopia showed enhanced sensitivity, and astigmatism demonstrated regional variations. These findings highlight the need for individualized approaches in clinical refractive management.

Keywords: Astigmatism, Hyperopia, Myopia, Refraction, Ocular, Sensory Thresholds, Vision Tests, Visual Fields

INTRODUCTION

Understanding how refractive errors influence visual field sensitivity is essential in optometry and ophthalmology, as these conditions significantly impact visual function. While extensive research has explored age-related changes in visual fields among elderly populations, limited attention has been given to young adults. Investigating these patterns in younger individuals is crucial, particularly given the increasing prevalence of refractive errors such as myopia, hyperopia, and astigmatism in this age group. Changes in visual field sensitivity associated with these conditions could have implications for both clinical assessment and management strategies (1). Existing literature presents inconsistent findings regarding the relationship between refractive errors and visual field sensitivity. Some studies suggest an age-dependent decline in sensitivity, particularly in myopic individuals, while others report a reduction in peripheral sensitivity among those with high myopia. However, systematic evaluations of regional variations across different refractive conditions remain scarce, especially in young adults (2,3). This study aims to address this gap by examining how myopia, hyperopia, and astigmatism influence visual field sensitivity, considering both regional differences and the impact of refractive correction.

Refractive errors arise from abnormalities in the eye's optical system, leading to improper focusing of light on the retina. Myopia is characterized by an elongated axial length, causing light to converge in front of the retina and resulting in blurred distance vision (4-6). Hyperopia, conversely, occurs when the axial length is shorter than normal, causing light to focus behind the retina and impairing near vision. Astigmatism, a result of irregular corneal or lenticular curvature, creates multiple focal points on the retina, leading to overall visual distortion. These refractive errors alter the distribution of light across the retina, potentially reducing visual field sensitivity. Although corrective measures such as spectacles, contact lenses, and refractive surgeries can mitigate these effects, the extent to which they restore normal field sensitivity remains unclear (7,8). The visual system generally functions optimally in young adults between 18 and 30 years of age, maintaining both central and peripheral vision at peak efficiency. However, refractive errors are becoming increasingly prevalent within this demographic, with myopia showing a particularly alarming rise worldwide. This trend is attributed to genetic predisposition and environmental factors such as prolonged near-work activities and reduced outdoor exposure. The growing burden of myopia and other refractive errors raises concerns about their potential effects on visual function, including alterations in visual field sensitivity (9,10).

Given the rising prevalence of refractive errors and their possible impact on visual field sensitivity, this study seeks to determine how different refractive conditions influence regional variations in the visual field among young adults. By identifying these changes, the findings could enhance understanding of the functional implications of refractive errors, guiding clinical decision-making and management strategies.

METHODS

This cross-sectional study was conducted over four months in various outpatient departments of public sector hospitals. The sample size was determined to be 58 using the formula $n = z^2 * p(1 - p) / d^2$, ensuring adequate statistical power. Participants were selected using a convenient random sampling method, including individuals aged 18 to 30 years of both genders with varying degrees of refractive errors. Exclusion criteria comprised individuals with a history of mental retardation, ocular trauma, or any ocular disease that could affect visual field sensitivity, ensuring that only refractive errors were assessed in relation to visual field changes. Data collection involved a comprehensive ophthalmic examination utilizing an auto-refractometer for objective refractive assessment, a trial frame for subjective refraction, and Snellen and near vision charts for visual acuity testing. The Humphrey Visual Field Analyzer was employed to assess visual field sensitivity. The study protocol included sequential testing, beginning with visual acuity assessment, followed by refraction measurement and visual field analysis. The comparison of visual field parameters was conducted in relation to age, refractive error type, and the presence or absence of refractive correction.

Ethical approval was obtained from the Superior University Lahore Ethics Committee, ensuring adherence to ethical research standards. Informed written consent was secured from all participants after explaining the study's purpose, confidentiality measures, and their right to voluntary participation. The study upheld ethical principles, including data confidentiality and participants' autonomy in decision-making. Data analysis was performed using SPSS version 25, applying appropriate statistical methods to evaluate associations between refractive errors and visual field parameters.

RESULTS

The study included 58 participants, categorized into three age subgroups: 18–22 years (n = 19), 23–26 years (n = 16), and 27–30 years (n = 23). The distribution of refractive errors included 26 individuals with myopia, 2 with hyperopia, and 30 with astigmatism. Among astigmatic patients, 10 had myopic astigmatism, 10 had hyperopic astigmatism, and 10 had mixed astigmatism. Visual field sensitivity

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deviations were analyzed using Humphrey perimetry, considering the effects of age, glasses prescription, and refractive correction across the four quadrants of the visual field. In the myopic group, visual field sensitivity was assessed based on prescription strength and refractive correction status. Superior quadrant deviation remained stable across prescriptions from -0.25 to -3.75 diopters (D), with a minor deviation of -0.05 dB observed in individuals with -4.0 D at 22 years of age following refractive correction. Inferior quadrant deviations ranged from -0.3 dB (at -1.75 D) to -0.75 dB (at -2.0 D), with variations noted among refractive-corrected patients aged 19 to 30 years. Nasal deviations remained unchanged for prescriptions between -0.25 and -1.25 D, while deviations from -0.05 dB to -0.7 dB were observed in patients with prescriptions of -1.00 to -1.50 D at 19 and 22 years. Larger deviations, ranging from -0.3 dB to -1.25 dB, were recorded in non-refractive-corrected individuals with -1.75 to -4.0 D at 20, 25, and 30 years. Temporal deviation remained stable across prescriptions, except for a -0.5 dB reduction in sensitivity at -4.0 D in non-refractive-corrected patients aged 30 years.

In the hyperopic group, superior quadrant sensitivity increased by 1.5 to 2.6 dB in refractive-corrected individuals aged 18 and 19 years. Inferior quadrant sensitivity showed a 2.0 dB increase in refractive-corrected individuals of the same age group. No significant nasal deviation was observed with +0.5 or +1.0 D prescriptions, but sensitivity increases of 1.5 dB and 1.0 dB were noted in refractive-corrected individuals. Temporal quadrant sensitivity increased by approximately 2.0 dB in refractive-corrected patients. Among astigmatic individuals, no significant superior quadrant deviations were observed in any subtypes. However, hyperopic astigmatism with a +3.00 D prescription showed a -0.1 dB reduction in inferior sensitivity at age 24. Myopic astigmatism was associated with nasal sensitivity reductions ranging from -0.6 dB to -1.0 dB, with variations seen between refractive-corrected and non-corrected patients aged 19 to 29 years. Temporal quadrant sensitivity decreased in myopic astigmatism patients, showing deviations of -0.2 dB to -0.7 dB at varying prescriptions and ages.

Statistical analysis revealed no significant deviations in visual field sensitivity for myopic patients across superior, inferior, nasal, and temporal quadrants, suggesting that variations observed in the data may not be clinically meaningful. However, significant sensitivity deviations were noted in the nasal ($p = 0.044$) and temporal ($p = 0.047$) quadrants for astigmatic patients, indicating potential regional effects of astigmatism on visual field function. The absence of comparative normal values or normative databases limits the ability to determine the clinical relevance of these deviations. Additionally, hyperopic findings could not be statistically validated due to the small sample size, restricting generalizability. Future studies with larger sample sizes and direct statistical comparisons across groups are necessary to strengthen conclusions.

Table: Myopic Patients' Visual Field Sensitivity Deviations

Age Group (Years)	**Number of Myopic Patients**	**Superior Deviation (dB)**	**Inferior Deviation (dB)**	**Nasal Deviation (dB)**	**Temporal Deviation (dB)**
18-22	9	No change (-0.25 to -3.75)	-0.3 (-1.75)	-0.05 to -0.7 (-1.00 to -1.50)	No change (-0.25 to -3.75)
23-26	8	No change (-0.25 to -3.75)	-0.5 (-3.25)	-0.3 (-1.75)	No change (-0.25 to -3.75)
27-30	9	-0.5 (at -4.0)	-0.75 (-2.0)	-1.25 (-3.75 to -4.0)	-0.5 (-4.0)

Table: Visual Field Sensitivity Changes in Hyperopic and Astigmatic Patients

Refractive Error Type	**Number of Patients**	**Superior Deviation (dB)**	**Inferior Deviation (dB)**	**Nasal Deviation (dB)**	**Temporal Deviation (dB)**
Hyperopia	2	+1.5 to +2.6 (Refractive corrected)	+2.0 (Refractive corrected)	+1.5 (0.5 glasses)	+2.0 (0.5 glasses)
Myopic Astigmatism	10	No change	-0.4 (-3.00 at 19)	-0.6 (-2.5 at 27)	-1.0 (-3.00 at 27)
Hyperopic Astigmatism	10	No change	-0.1 (-3.00 at 24)	-1.0 (SE 5 at 26)	-0.04 (0.75 at 29)
Mixed Astigmatism	10	No change	-0.9 (SE 4 at 25)	-0.5 (-3.00 at 25)	-0.5 (SE 4 at 25)

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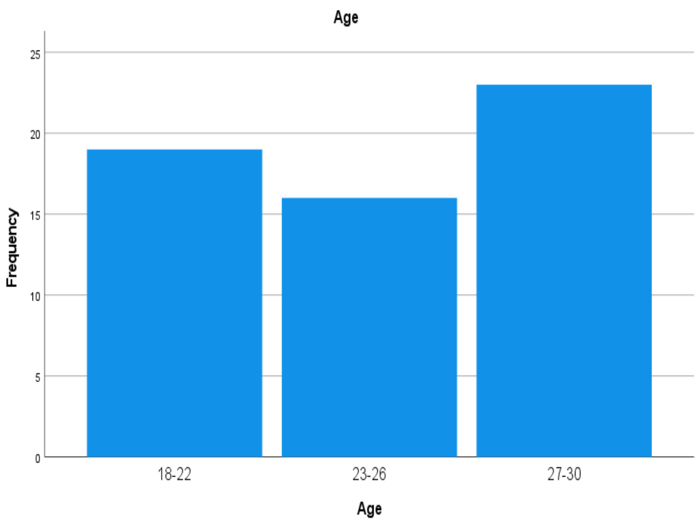

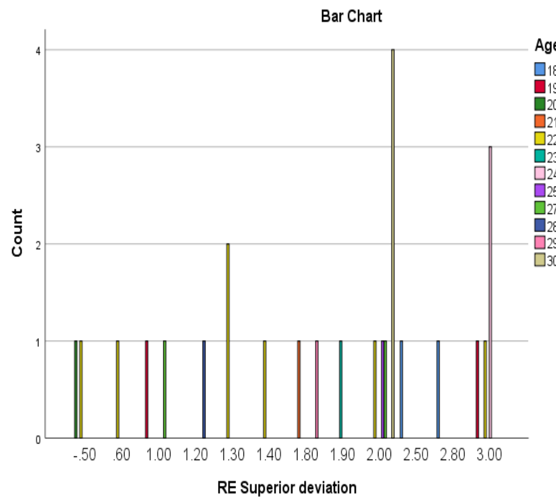

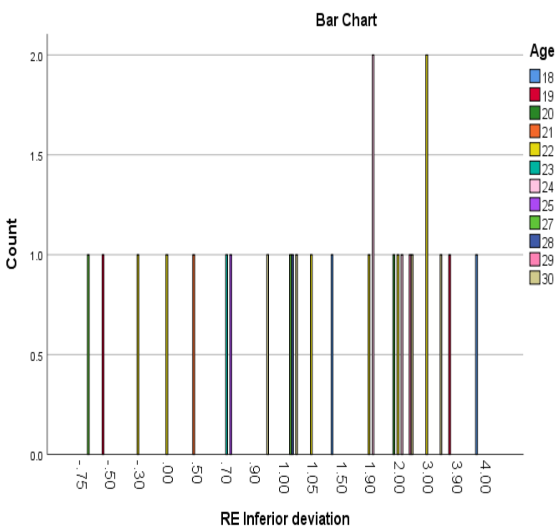

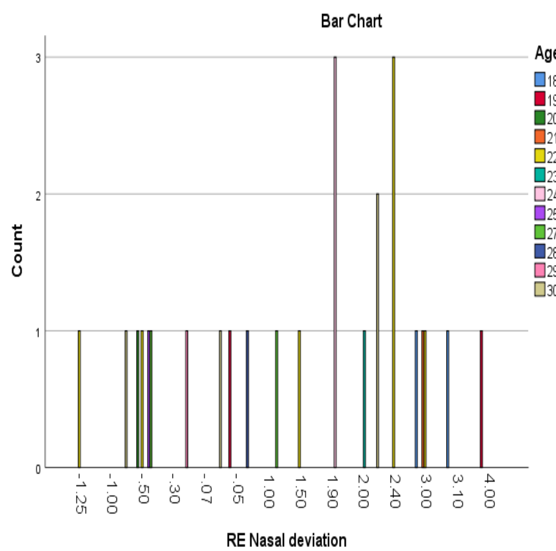

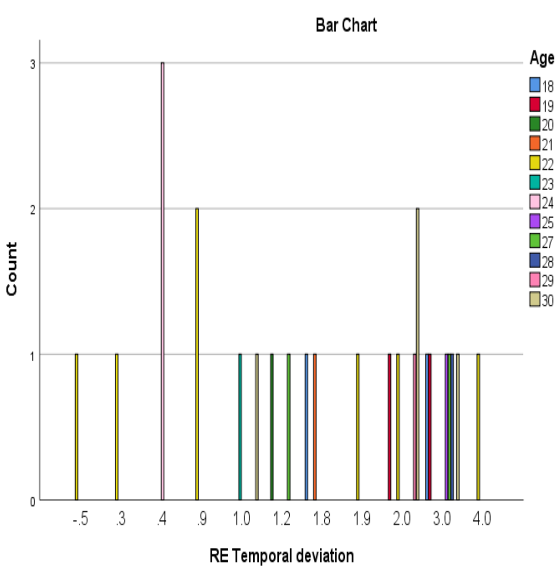

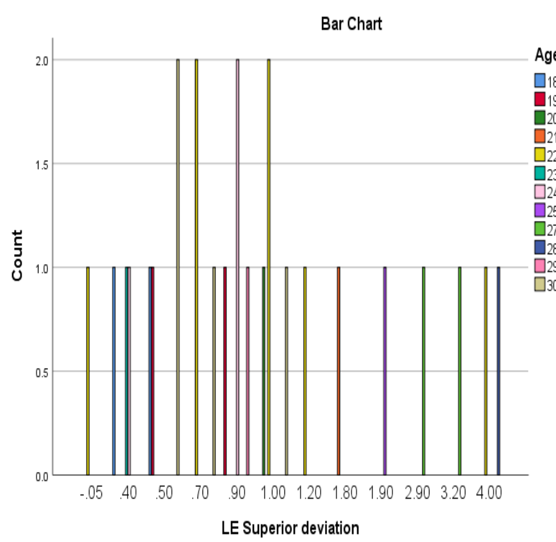

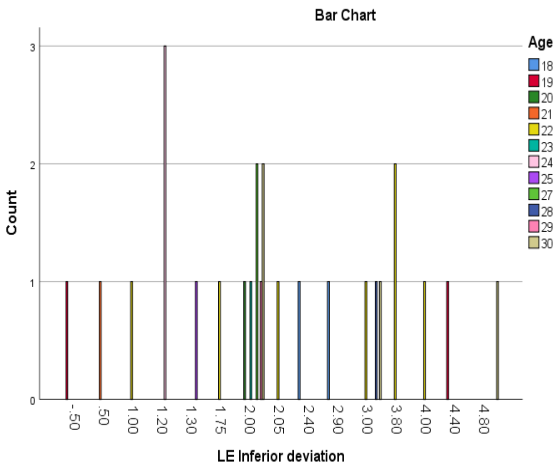
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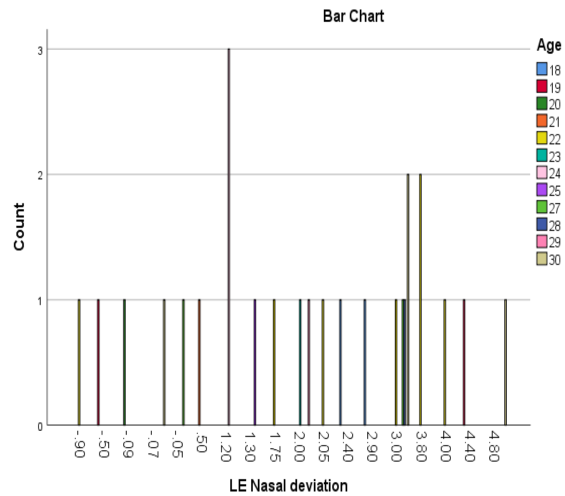
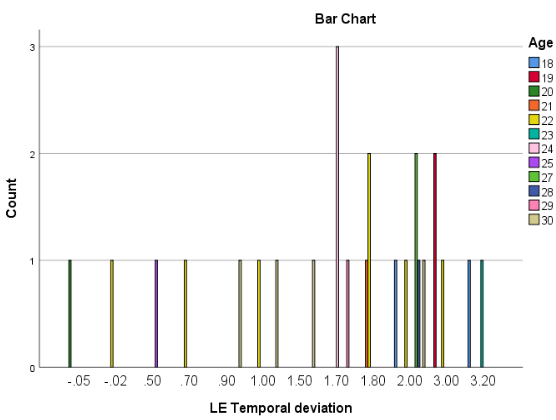
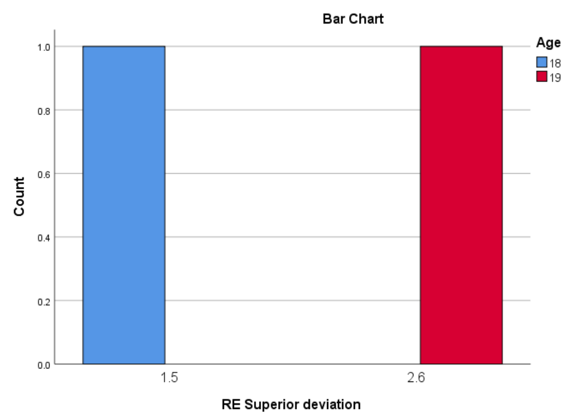
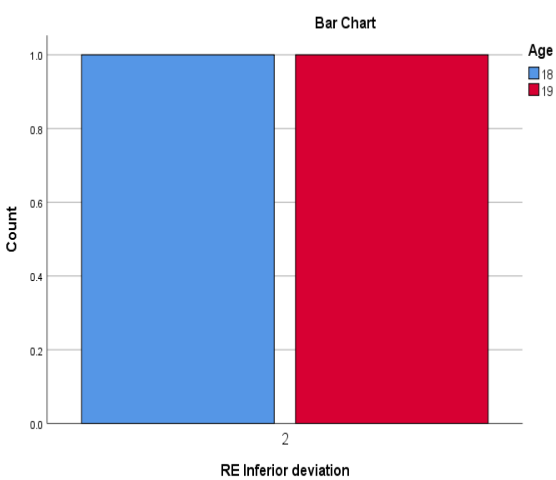
Count
LE Inferior deviation
-.50 .50 1.00 1.20 1.30 1.75 2.00 2.05 2.40 2.90 3.00 3.80 4.00 4.40 4.80
Age
18 19 20 21 22 23 24 25 27 28 29 30


Bar Chart
Count
LE Nasal deviation
-.90 -.50 -.09 -.07 -.05 .50 1.20 1.30 1.75 2.00 2.05 2.40 2.90 3.00 3.80 4.00 4.40 4.80
Age
18 19 20 21 22 23 24 25 27 28 29 30


Bar Chart
Count
LE Temporal deviation
-.05 -.02 .50 .70 .90 1.00 1.50 1.70 1.80 2.00 3.00 3.20
Age
18 19 20 21 22 23 24 25 27 28 29 30


Bar Chart
Count
RE Superior deviation
1.5 2.6
Age
18 19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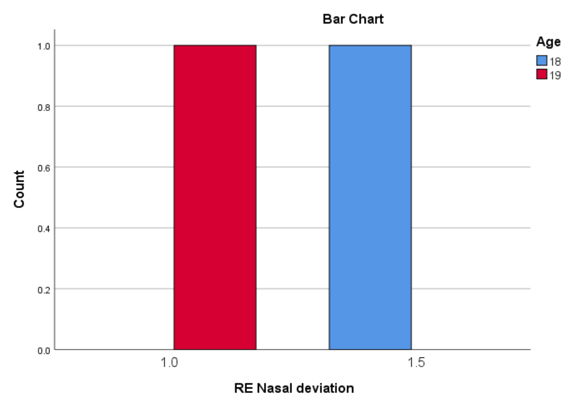
Count
RE Inferior deviation
2
Age
18 19


Bar Chart
Count
RE Nasal deviation
1.0 1.5
Age
18 19

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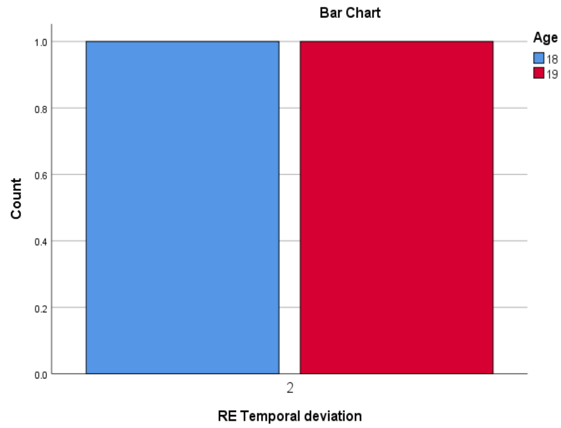

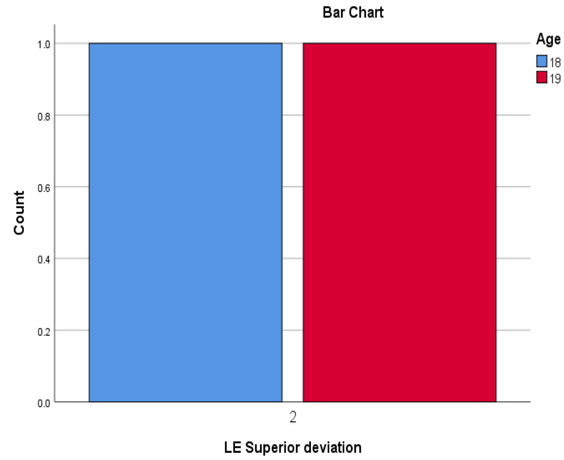

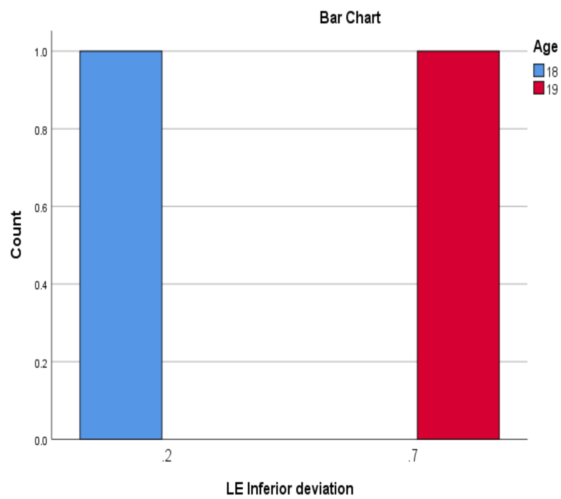

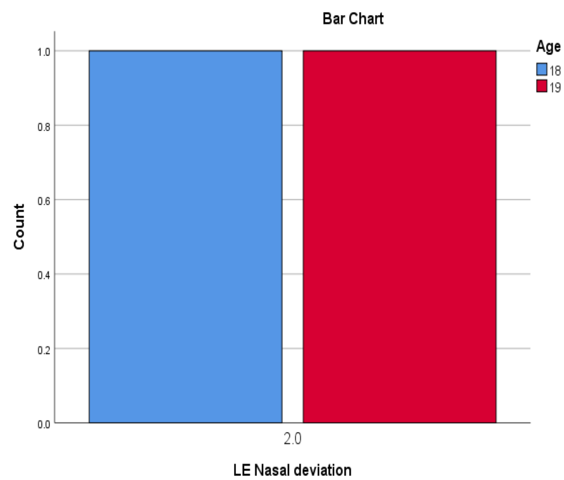

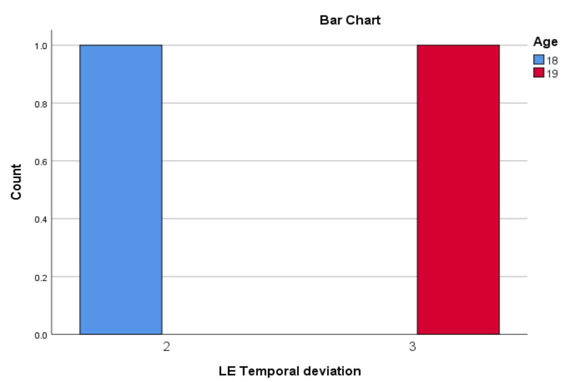

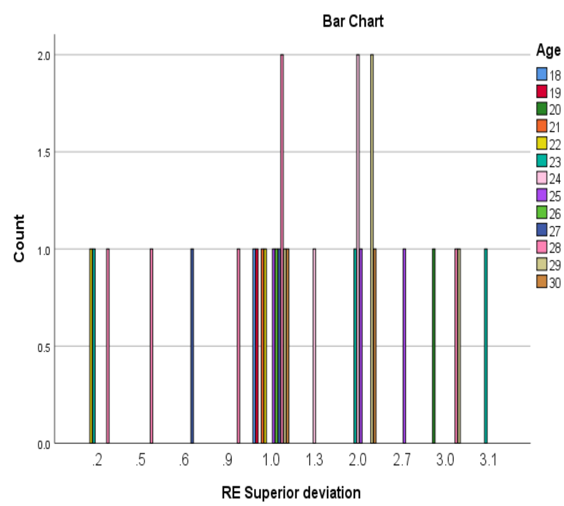

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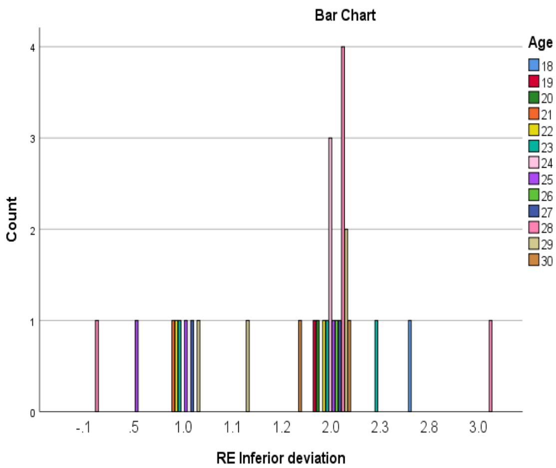

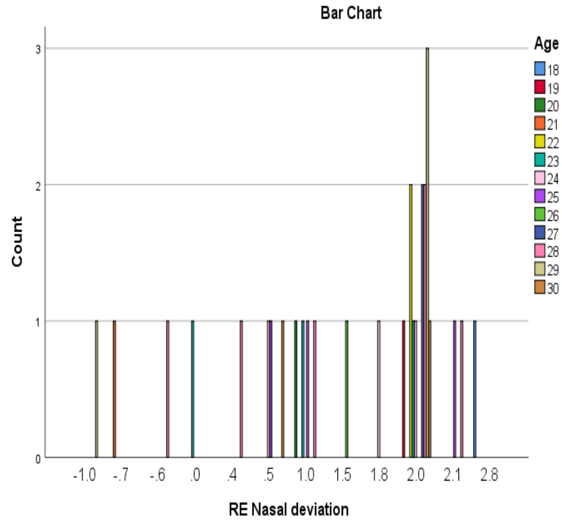

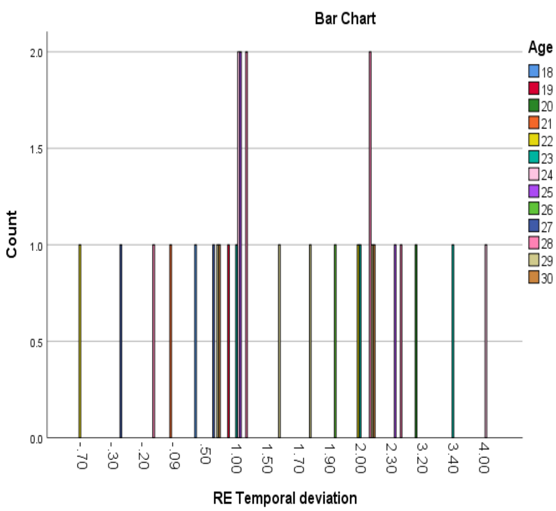

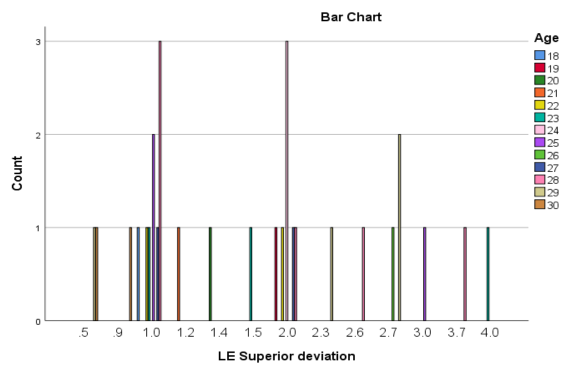

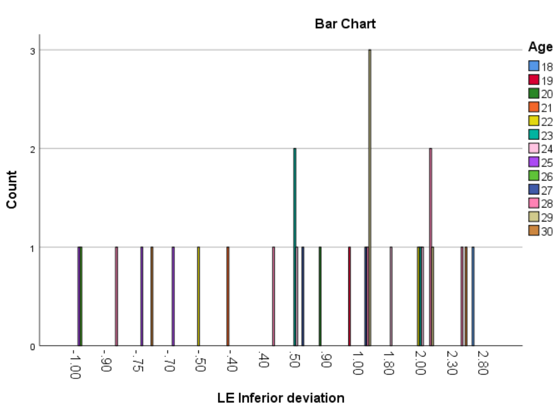

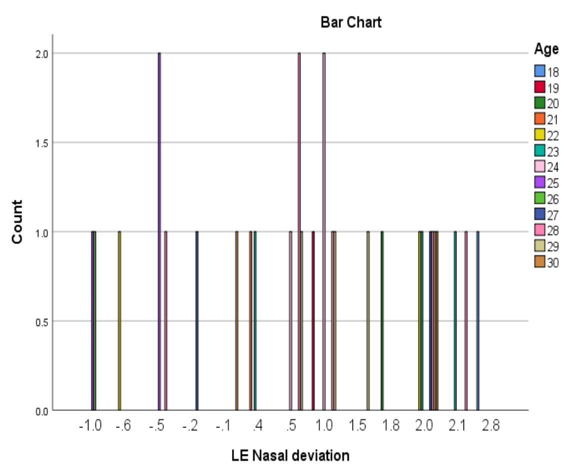

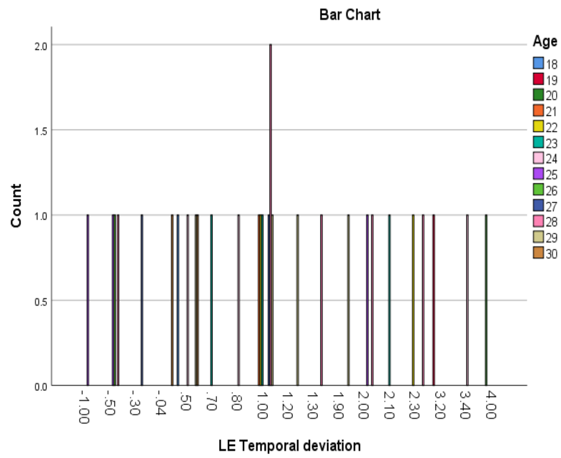

DISCUSSION

This study provides valuable insights into visual field sensitivity variations among young adults with different refractive errors. The findings align with some existing literature while also revealing novel patterns that warrant further investigation. In myopic individuals, the observed reduction in visual field sensitivity, particularly in the peripheral regions, supports prior findings that higher degrees of myopia are associated with decreased sensitivity. However, the magnitude of deviations recorded in this study was generally smaller, likely due to the younger age group under examination. Notable variations in sensitivity were evident at ages 19, 20, 22, and 30 years, suggesting a possible correlation between refractive error severity and age-related visual field changes, although a larger sample is required to confirm this relationship (11-13). The findings in myopic individuals, with deviations ranging from -0.02 to -1.25 dB, are comparable to previous reports that have demonstrated decreased peripheral visual field sensitivity in individuals with moderate to high myopia. However, in contrast to prior studies that found significant nasal-temporal asymmetry, this study revealed less pronounced regional differences. This variation could be attributed to differences in sample demographics, refractive error ranges, or methodological factors. The asymmetric nature of visual field deviations highlights the potential biomechanical impact of myopia on retinal sensitivity, a subject that warrants further biomechanical and structural correlation studies (14-16).

The results in hyperopic individuals indicated an increase in visual field sensitivity, particularly in the temporal and nasal regions. This finding contrasts with previous studies that did not report significant enhancement in mild hyperopia. A younger age range in this study may have contributed to this discrepancy, as compensatory mechanisms in younger individuals may play a role in maintaining or even enhancing visual field performance. However, with only two hyperopic participants, the statistical reliability of these findings is limited. The absence of superior field deviation with +0.50D and +1.00D corrections is consistent with reports indicating stable visual function in mild hyperopia. Nevertheless, the increased sensitivity observed in inferior fields suggests an adaptive process that has not been widely documented in young hyperopic individuals, raising the need for further research to explore possible neurophysiological adaptations in hyperopia (17-20). Astigmatism did not demonstrate significant age-related variations in visual field sensitivity, consistent with previous studies reporting minimal changes in young adults with refractive errors. However, the pronounced temporal field sensitivity decreases in astigmatism provide new insights into regional variations that have not been extensively explored. The absence of superior field deviations across all astigmatic subtypes aligns with existing literature suggesting that central and superior field sensitivity remains stable in young populations (21-25). The observed nasal field sensitivity decrease of 0.6 to 0.7 dB in both hyperopic and myopic astigmatism corresponds with previous findings that reported similar magnitudes of change in astigmatic individuals. However, the -1.00 dB deviation observed in myopic astigmatism with a spherical equivalent of 1.5 suggests a more pronounced effect than previously documented, emphasizing the need for further investigation into the structural and functional effects of astigmatism on retinal sensitivity (26-30).

A key strength of this study is its focus on young adults, a population in which refractive error-related visual field sensitivity changes have not been extensively studied. The detailed quadrant-wise analysis allows for a more nuanced understanding of regional visual field variations associated with different refractive errors. However, the study has certain limitations, including a relatively small sample size, particularly for hyperopic participants, and an uneven gender distribution, which may influence generalizability. Additionally, the refractive error range, particularly in hyperopia, was narrow, limiting the ability to evaluate a broader spectrum of hyperopic refractive states. The study also did not incorporate long-term follow-up, restricting the ability to assess progressive visual field changes over time (31-33). To address these limitations, future studies should incorporate larger, more gender-balanced samples and broader refractive error ranges, particularly in hyperopia. Longitudinal research designs should be considered to evaluate progressive changes in visual field sensitivity over time. Additionally, further research is needed to explore eye-specific patterns in visual field deviations, monitor

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myopic visual field alterations, and track temporal field changes in astigmatic individuals. Investigating the mechanisms underlying asymmetric enhancement in hyperopia and assessing the relationship between accommodation and visual field sensitivity could provide valuable insights. Moreover, understanding the impact of different refractive correction methods on visual field performance, along with evaluating environmental influences such as digital device usage, may contribute to a more comprehensive understanding of refractive error-related visual field changes (32,33).

CONCLUSION

This study highlights the intricate relationship between refractive errors and visual field sensitivity, emphasizing the distinct patterns observed across different refractive conditions. Myopic individuals exhibited age-related variations in sensitivity, while hyperopic individuals demonstrated localized enhancements, particularly with refractive correction. Astigmatic individuals showed regional differences in sensitivity without a clear age-related trend. These findings reinforce the need for individualized assessment and management strategies in clinical practice, considering the potential impact of refractive errors on visual field performance. Understanding these variations is essential for optimizing visual function and tailoring corrective approaches to ensure the best possible visual outcomes.

AUTHOR CONTRIBUTIONS

Author	Contribution
Sobia Yousif	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision
Prof Dr. Rashida Perveen	Methodology, Investigation, Data Curation, Writing - Review & Editing
Ayesha Saleem	Investigation, Data Curation, Formal Analysis, Software
Iqra Manzoor	Software, Validation, Writing - Original Draft
Rabia Akram	Formal Analysis, Writing - Review & Editing
Hamna Ahmad	Writing - Review & Editing, Assistance with Data Curation
Aleeza Naeem	Writing - Review & Editing, Assistance with Data Curation
Ghashia Gul	Writing - Review & Editing, Assistance with Data Curation

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