Age-related trends in visual field sensitivity using a head-mounted visual analyzer

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Abstract— With advancing age visual field sensitivity may decline. Visual field (VF) assessment serves as a key factor in the early detection of visual impairment. Though gold standard the conventional automated perimetry has challenges related to accessibility, patient affordability and resource constraints. Head mounted visual analyzers (HMVA) are portable and easy to handle. It can be used for screening in broader population and is cost effective. Objective: Age-related patterns and associations of visual field sensitivity in healthy adults with a head mounted visual analyzer. Materials and methods: It is a cross-sectional observational study involving 60 healthy volunteers aged between 21-69 years. Participants were evaluated for visual parameters such as Mean deviation (MD), Total deviation (TD) including Pattern standard deviation (PSD) with Elisar AVA HMVA. All the parameters representing visual field sensitivity remained normal across the ages. The predicted values were aligned and matched with the observed values. The sensitivity of the visual field was found to be stable, showing no decline with advancing age. Hence it can be concluded that HMVA can be used as a portable, cost-effective device for screening on a larger scale. *(Abstract)*

Index Terms— Visual field sensitivity, Head-mounted visual analyzer, Perimetry, Elisar AVA. *(key words)*

I. INTRODUCTION (HEADING 1)

Visual field (VF) assessment is an important basis of functional visual loss and assists in the early diagnosis and monitoring of a comprehensive spectrum of ocular and neurological diseases. The visual field consists of the entire area visible to an individual when the eyes are focused on a single point. This big image view is a key attribute for navigation and awareness of the environment, it reflects the integrity of the retina, optic nerve, visual pathways and visual cortex.

The assessment of visual field is critical for early detection of changes in visual function by looking into the field before any structural damage has occurred [1–3]. Therefore, reliable testing of visual sensitivity is important for early diagnosis and monitoring of conditions such as glaucoma and other neurological diseases. Perimetry plays an important role in evaluating visual function across different retinal regions. Loss of retinal ganglion cells and their axons eventually lead to detectable visual field defects. For this reason, visual field testing is widely used in neuro-ophthalmology, as specific patterns of field loss often help localize lesions along the visual pathway. In addition to glaucomatous damage, retinal disorders such as age-related macular degeneration and vascular diseases may also produce localized or generalized reductions in sensitivity. Therefore, consistent and reproducible measurements but also for understanding age-related trends in visual function.

Aging is recognized as an important factor influencing visual performance, even in individuals without overt ocular disease. With advancing age, gradual reductions in retinal ganglion cell density, photoreceptor efficiency and neural conduction velocity. Cortical processing may also undergo subtle age-related alterations. Environmental exposure, occupational visual demand, lifestyle habits and systemic health conditions can further influence visual sensitivity over time.

Given these factors, evaluating visual field parameters using age-related reference values becomes essential. Although conventional automated perimetry incorporates age matched databases, periodic re-evaluation of such trends remains important particularly when newer technologies are introduced.

Standard automated perimeters, including the Humphrey field analyzer, are widely regarded as the reference method for visual assessment. These systems utilize static threshold testing and have been extensively validated in both clinical and research settings. However, their size, cost and infrastructure requirements may limit their use in large-scale or community-based screening programs. In addition, prolonged testing duration may lead to fatigue, especially in elderly individuals.

Head mounted visual analyzers use virtual reality-based display systems combined with infrared eye-tracking technology to monitor fixation and deliver stimuli precisely. These devices are compact and require minimal physical space making them convenient for clinical settings. Their probability makes them useful for geriatric populations and tele-ophthalmology.

Modern HMVA devices, such as the Elisar AVA, are designed to function like standard automated perimetry systems but without the limitations of older analog machines. They provide controlled luminance, real-time fixation tracking and automated reliability indices. The testing and analysis are performed automatically using the collected perimetric data, which reduces human error. As a result, these devices show better accuracy and reproducibility compared to conventional perimetric devices. Head-mounted display systems may also decrease environmental distractions and have potential to enhance patient engagement leading to an increased patient’s confidence of test performance, especially among elderly patients. However, the standardized normative data of the HMVA-based visual field testing is limited. There is scarcity of data assessing age-dependent visual field sensitivity trends using head-mounted perimetric devices, particularly within the Indian population. Population-specific standard data are needed for accurate interpretation and clinical decision-making, considering ethnic, environmental, and demographic differences that could affect visual function. Hence, our study aims to assess visual field sensitivity across different age groups using head-mounted visual analyzer.

II. MATERIALS AND METHODS

This cross-sectional study was conducted at Rajarajeswari Medical College & Hospital, Bangalore for a duration of 3 months after approval from the Institutional ethical committee (RRMCH-IEC/315/2025). Sixty healthy subjects aged between 21 – 69 years were recruited for the study. Participants were divided into five age groups with a best corrected visual acuity score of more than or equal to 6/9. Subjects with the history of glaucoma, media opacities, retinal or macular degeneration, diabetes or hypertension, chronic smokers/alcoholics and subjects with ocular surgery history were excluded from the study.

Protocol for visual field-testing:

Visual field examination was performed by Elisar AVA Head-Mounted Visual Analyzer (Neuro-Equilibrium Diagnostics Pvt. Ltd, Jaipur) based on a validated protocol. Tests were conducted with low lighting in a stable environment to decrease environmentally mitigating visual noise. Participants were seated comfortably and best-corrected visual acuity to 6/9 was confirmed prior to testing. The procedure was explained to the participants and trial test was conducted before starting the recording. Tests were performed monocularly for both the eyes by occluding the contralateral eye. Participants were instructed to maintain the central fixation and to respond by pressing the handheld button when presented with stimulus.

Central visual field test (24–2) assessment by using a white stimulus and both the left and right eyes were tested. Fixation monitoring was carried out by recording fixation losses, false positive errors and false negative errors. Outcome measures included Mean Deviation (MD), Total Deviation (TD), Pattern Standard Deviation (PSD) and Visual Field Index (VFI).

Statistical Analysis:

Descriptive statistics are used to summarize visual field parameters. Correlations between age and the chosen visual field parameters were examined using Pearson's correlation analysis to assess age-dependent trends in visual field sensitivity.

III. RESULTS

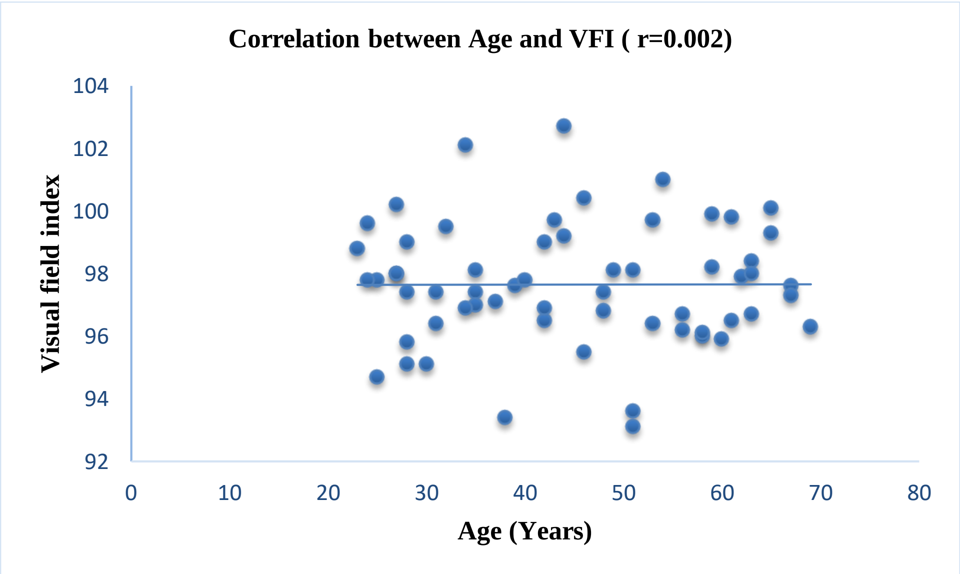
Table 1: The age wise distribution of Visual field parameters

Age groups (Years)	No. of subjects	MD (dB) Mean ± SD	TD (dB) Mean ± SD	PSD (dB) Mean ± SD	VFI (%) Mean ± SD	Predicted VFI (%)
21-29	12	-0.74 ± 1.23	0.23 ± 1.44	1.52 ± 0.55	97.68 ± 1.64	97.7
30-39	12	-1.08 ± 1.22	0.36 ± 1.63	1.33 ± 0.38	97.33 ± 2.03	97.3
40-49	12	-0.70 ± 0.95	0.22 ± 1.47	1.54 ± 0.48	98.33 ± 1.90	98.3
50-59	12	-0.76 ± 0.63	0.09 ± 1.14	1.81 ± 0.41	97.08 ± 2.30	97.1
60-69	12	-1.12 ± 0.96	0.98 ± 1.53	1.49 ± 0.54	97.81 ± 1.32	97.8

MD- Mean deviation; TD- Total deviation; PSD- Pattern Standard Deviation; VFI- Visual Field Index

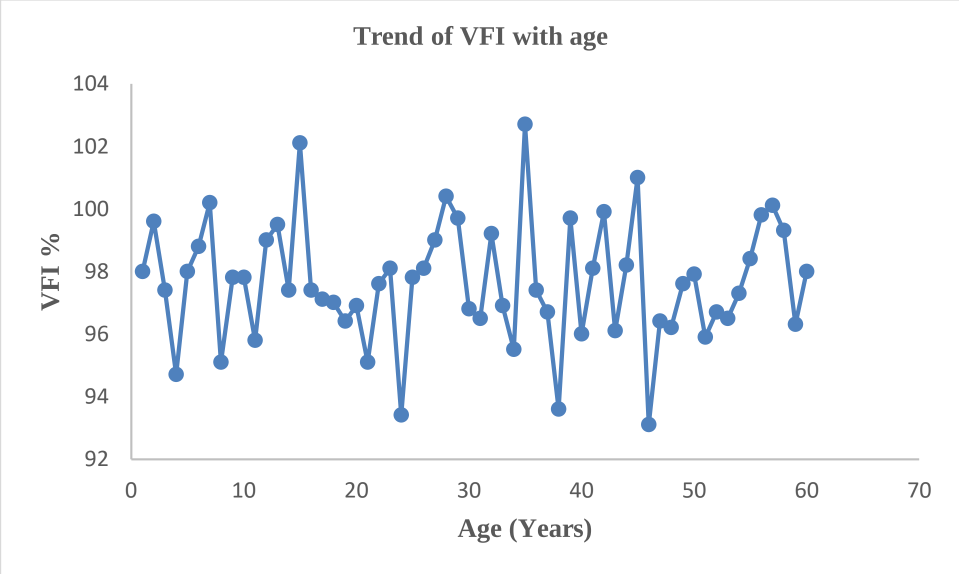
All evaluated visual field parameters remained in normal physiological limits across age groups. VFI values were consistently above 97 % and matched with predicted standard values.

FIGURE 1:



VFI values remain consistently high across all age groups, showing preservation of VF sensitivity. The trend line is almost flat, and correlation coefficient is close to 0 zero (r=0.002). Hence, it can be concluded there is no significant age-related decline in VFI among healthy adults.

FIGURE 2:



The Visual Field Index (VFI) values remained within the normal physiological range across all participants. No consistent declining trend was observed, indicating stable visual field sensitivity in healthy individuals.

IV. DISCUSSION

In the current study, MD, TD and PSD values remained within normal physiological limits across all age groups. Visual field sensitivity also remains stable from early to late adulthood. These data indicate that in a healthy population without ocular or systemic comorbidities, age-dependent changes in visual field sensitivity are relatively small and are largely stable in physiological conditions, demonstrating that age did not have clinically significant impact on VF sensitivity in healthy population.

Our results are in contrast with various previous studies that reported the presence and measurable deterioration of visual performance with structural and functional changes as age advances. Narang et al. observed greater reductions in retinal ganglion cell thickness and visual field sensitivity among glaucomatous patients, where disease related neurodegeneration may amplify age related changes [5].

Similarly, Hadziahmetovic et al. reported deterioration in visual parameters in individuals with retinal involvement, indicating that structural pathology may contribute to functional decline [2].

Large normative databases studies using conventional automated perimetry have shown gradual reductions in differential light sensitivity with advancing age, particularly in peripheral visual field sites. Heijl el al. reported progressive reduction in mean deviation values with age, even among healthy individuals, though the changes were more pronounced in glaucomatous eyes [9].

Correspondingly, Spry and Johnson estimated a reduction of approximately 0.4-0.6 dB per decade, reflecting gradual physiological aging rather than overt impairment [11].

However, studies such as those by Gardiner et al. and Artes et al. have suggested that age-related visual field changes are relatively small when age-appropriate reference databases are applied [8,11]. These results suggest that physiological aging alone does not necessarily lead to clinically significant visual field impairment. Variations between studies may be explained in study design, population characteristics, and testing methodologies.

Previous studies often investigated broader age cohorts or individuals with subclinical changes in the lenses, early vascular disease, or undiagnosed metabolic diseases that may overestimate the impact of aging on functional decline. In our study participants were selected to exclude ocular and systemic confounders. This selection may have contributed to the preservation of VF sensitivity across age groups.

Chauhan et al. have further emphasized that functional changes detected by perimetry may lag structural alterations in the retina. Therefore, subtle structural age-related changes may not always translate into measurable functional decline, particularly when age-corrected normative data are used. [14].

This observation may also be related to improved healthcare services, routine eye checkups and increased awareness regarding ocular health. Lifestyle modifications such as healthy diets, a person-centered approach to chronic systemic diseases and eye protection with ultraviolet-shielding glasses can sustain eye vision in later life.

Importantly, the close agreement between observed VFI values and predicted age-adjusted standard values supports the reliability of HMVA-based perimetry in this cohort. Validation studies comparing virtual reality-based systems with Humphrey automated perimetry have reported encouraging sensitivity, specificity and repeatability [5, 16].

The portability and ease of use of HMVAs may offer practical advantages, particularly in community-level screening and resource-limited settings. In regions where access to conventional perimetry is restricted, such devices may support early identification of glaucomatous and neuro-ophthalmic disorders [16].

V. CONCLUSION

This study demonstrates that visual field sensitivity remains largely stable across age groups in healthy adults. The head-mounted visual analyzer showed consistent results and appears suitable for use in screening settings. Nevertheless, larger longitudinal studies with broader population representation are required to further validate age-related normative data.

VI. Acknowledgment

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