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Study of Visual Function in Myopic Young Adults

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ABSTRACT

Objectives: The objective is to study visual function among young myopic adults and its association with the degree of myopia.

Material and Methods: A six-month (from January 2024 to June 2024) Prospective Cross-sectional study was conducted. A total of 75 participants with a mean age of 20.24 years were included in the study. To rule out any pathology or retinal abnormalities, each participant underwent a complete eye examination prior to the visual function test. The degree of myopia was assessed to identify any significant differences in visual functions, including colour vision, near point of convergence, near point of accommodation, contrast sensitivity, visual field, axial length, and stereopsis.

Results: The statistics on visual function for the eye power categories are reported as mean, standard deviation, and standard error. The means were analysed using one-way analysis of variance (one-way ANOVA) and the Bonferroni 't' test for post-hoc multiple comparisons. The mean age of participants was 20.24 years, and the distribution of myopia was done as -1.75D and less, -2D to -3.75D, -4D to -5.75D, and -6D and above. The statistical analysis revealed significant variations in axial length ($P < 0.001$) and stereopsis ($P = 0.002$). However, near point of convergence ($P=0.101$) and near point of accommodation ($P=0.773$) did not show any difference.

Conclusion: The study shows that adults with different degrees of myopia have increased visual function variation requiring proper care.

Keywords: Accommodation, Convergence, Myopia, Visual function, Young adults

INTRODUCTION

Myopia is the most common refractive defect in India and throughout the world India has the largest percentage of youth population in the world, with over 808 million individuals under the age of 35 years Myopia is a major contributing factor to ocular morbidity, especially in the younger generation—children and young people enrolled in school.[1]

According to the International Agency for the Prevention of Blindness (IAPB) and the World Health Organization (WHO), refractive error is the second leading cause of blindness, following cataracts.

Severe forms of myopia (more than -6.00 D) impact 170 million people (almost one-fifth of the world's myope population), causing disorders such as retinal detachment, choroidal neovascularisation, glaucoma, macular atrophy, and other conditions leading to late-life visual loss. These conditions are estimated to affect 22.9% of the global population, or approximately 1.893 billion people.[2]

Few researchers have examined the assessment of visual function in myopic patients, even though several quantitative studies have been carried out to determine the prevalence of myopia.

Visual function refers to the ability of the visual system to enable objective observation of the external world. Colour vision, fields, contrast sensitivity, and stereopsis, or depth perception, are the fundamental components of visual function.

The difficulty in differentiating between specific colours is known as colour vision deficiency (CVD) or colour blindness, and it may be a contributing factor to vision-related issues in young people at the workplace. According to studies, 0.4% to 3% of women and 1% to 8% of males suffer from CVD.[3] Contrast sensitivity function (CSF) can provide a more comprehensive evaluation of spatial vision, comprising its optical, retinal, neural, and adaptive skills, in contrast to visual acuity (VA), which only examines spatial resolution at high contrast.[4]

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Stereopsis affects many aspects of life. It facilitates the identification of various objects in addition to aiding in the perception of distance and depth. Stereopsis is a crucial aspect of binocular vision, which involves the brain receiving visual stimuli from both eyes to produce a perception of depth. The capacity to perceive depth by superimposing two photographs of the same object from slightly different angles is known as three-dimensional vision. Stereopsis often begins in the fourth month of infancy, progresses by the age of six, and worsens after forty.[5] The presence of refractive anomalies, such as astigmatism, hypermetropia, or myopia, can contribute to a reduction in stereopsis in an individual. This is a result of the conditions not being fulfilled, which prevents a satisfactory stereoscopic vision. Contrast sensitivity is a more reliable measure of visual loss in everyday life compared to visual acuity. The formula for the contrast threshold is $(L_{max} - L_{min})$ / (Lmax + Lmin), where Lmax and Lmin represent the highest and lowest brightness levels, respectively. The inverse of the contrast threshold is known as contrast sensitivity. When compared to emmetropes, myopes exhibited less contrast sensitivity with best-corrected visual acuity. The degree of myopia increases with a decrease in contrast sensitivity.[6] The Pelli-Robson chart is one of the most used charts for determining contrast sensitivity.[7]

This study is one of the few conducted on the effect of stages of myopia on vision.

MATERIAL AND METHODS

A prospective cross-sectional study was conducted over six months (January to June 2024). The research was approved by the Institutional Scientific Review Board of Saveetha College of Allied Health Sciences. (SCAHS/ISRB/2024/March/551) and follows the guidelines proposed by the declaration of Helsinki and the Indian Council of Medical Research. The study comprised 75 participants aged 18 to 35 years, and the sample size was determined using the purposive sampling technique. The participants provided written informed consent prior to the study's commencement. All the participants underwent a comprehensive eye examination. Full medical and ocular history was taken before the examination. Visual acuity (Distance and near), intra-ocular pressure, slit-lamp examination, and fundus examination were conducted to rule out any pathology or retinal changes. Visual acuity and subjective refraction were done. Colour vision, contrast sensitivity, NPA and NPC, and stereopsis were evaluated. Subjects with only myopic refractive errors were included. Subjects other than myopes, such as hyperopes, who had undergone refractive surgery and had anterior and posterior abnormalities, were excluded from the study.

Visual function assessment protocol: Binocular vision assessment was done in a room with standardised illumination levels and a room length of the standard distance of 6 m. The participant underwent a visual function assessment, which included colour vision, stereopsis, NPC, NPA, Axial length, and contrast sensitivity.

Colour vision was assessed using the Ishihara chart at a distance of 40 cm, monocularly, and the results were recorded. Stereopsis was assessed using the Titmus Random Dot test at a distance of 30 cm, with the subject wearing red-green glasses. Stereopsis was assessed with Best Corrected Visual Acuity. The contrast sensitivity was assessed monocularly using the Pelli-Robson Chart at a distance of 1 m. The NPC was evaluated using a Royal Air Force (RAF) ruler and a linear accommodative target of 6/9, as reduced by Snellen's letter. The tests were done three times, with the average recorded as NPC. The NPA was assessed using the RAF ruler, which involves bringing the near target closer to the eyes until a continuous blur is observed. The near target was evaluated at or slightly higher than the best-corrected near visual acuity. The endpoint of a blur was measured using the ruler. The test was performed binocularly, with three measurements taken for each eye. The average value was recorded in centimetres and converted to dioptres.

Statistical analysis

The data was analysed based on SigmaPlot 14.5 version (Systat Software Inc., San Jose, USA). The sample size calculation was also done using the same software. The collected data was checked for normal distribution using a statistical test. The data on stereopsis, axial length, near point of convergence, and near point of accommodation have been represented as mean, standard deviation, and standard error for the eye power categories. The means were examined using one-way analysis of variance (one-way ANOVA) and the Bonferroni 't' test for post-hoc multiple comparisons. A probability of 0.05 or less was considered statistically significant.

RESULTS

It was noted that 18.67 % of participants were male and 86.33% were female.

Table 1 indicates that the distribution of degrees of myopia was done based on dioptric power -1.75. Analysis showed that 13.3% of patients had a power less than -2, 54,7% had -2 to -3.75, 20% had -4 to -5.75, and 12% had -6 and above. Table 2 indicates a statistical difference among various parameters. Where n=75, -1.75 and less (D) = 10; - 2 to – 3.75 (D) = 41; - 4 to – 5.75 (D) = 15; - 6 and above = 9. The 'F' and 'P' values are obtained using one-way ANOVA with the Bonferroni 't' test for multiple comparisons. The results showed significant

Table 1: Distribution of patients in degrees of myopia

Degrees of myopia (D)	Number of patients	Percentage
-1.75 and less	10	13.3
-2 to -3.75	41	54.7
-4 to -5.75	15	20.0
-6 and above	9	12.0
Total	75	100

variation in axial length (P < 0.001) and stereopsis (P = 0.002). However, other parameters, such as NPC (P = 0.101) and NPA (P = 0.773), did not show any difference.

All 75 participants demonstrated readability of colour vision charts. The contrast sensitivity of all participants was normal, with a value of 2.0 log.

DISCUSSION

Visual function is very important in our day-to-day life, as it enables us to perceive our outer world. Approximately 80% of all perceptual input is processed by the eyes.

Most studies on refractive errors have focused on determining the prevalence and variables influencing it; however, there is limited research on the assessment of visual function among myopia individuals.

The present study focuses on assessing the visual function in myopic young adults. Similar studies have focused on comparing visual function in ametropes and emmetropes, and visual function characteristics have shown no significant difference, except for axial length, which was higher among the myopes.[8]

In the present study, the contrast sensitivity did not show any significant difference between degrees of myopia. Other studies noted a high risk of reduced stereopsis for refractive amblyopia, as well as an interocular variation in contrast sensitivity.[9] The present study indicates no significant variation in stereopsis up to <6 D in myopia adults. Studies conducted on children with colour vision deficiencies have shown a lower incidence of myopia, slower myopic progression, and less axial elongation compared to children with normal colour vision.[10] In the current study, colour vision and contrast sensitivity were normal, and we did not find any significant variation in visual field using confrontation method.

In the current study, the NPC and NPA were measured using the RAF rule for all degrees of myopia, with no significant variation observed. However, we found that among those with high, moderate, and low degrees of myopia, convergence and accommodation insufficiency was common. The study's statistics show that children with a modest degree of myopia had a higher likelihood of developing convergence

Table 2: Compression of eye power in degrees of myopia

S.No.	Variable	Eye power (D)	Mean	SD	SE	Statistics
1	Stereopsis (arc seconds)	-1.75 and less	96.0[a]	31.0	9.8	F = 5.482
		-2 to -3.75	115.6[b]	67.6	10.6	
		-4 to -5.75	96.0[c]	30.4	7.9	P = 0.002
		-6 and above	186.7[abc]	63.2	21.1	
2	Axial length (cm)	-1.75 and less	23.3[ad]	0.7	0.2	F = 19.161
		-2 to -3.75	23.7[be]	0.8	0.1	
		-4 to -5.75	24.5[cde]	0.5	0.1	P =< 0.001
		-6 and above	25.6[abc]	1.0	0.3	
3	Near point of convergence (cm)	-1.75 and less	6.0	0	0	F = 2.154
		-2 to -3.75	6.5	0.9	0.1	
		-4 to -5.75	6.8	1.0	0.3	P = 0.101
		-6 and above	6.2	0.7	0.2	
4	Near point of accommodation (cm)	-1.75 and less	15.0	2.1	0.7	F = 0.373
		-2 to -3.75	14.5	2.1	0.3	
		-4 to -5.75	14.7	2.1	0.5	P = 0.773
		-6 and above	15.2	2.1	0.7	

n = 75, - 1.75 and less (D) = 10; - 2 to – 3.75 (D) = 41; - 4 to – 5.75 (D) = 15; - 6 and above = 9 The 'F' and 'P' values are obtained using one-way analysis of variance (ANOVA) with the Bonferroni 't' test for multiple comparisons. SD: Standard deviation, SE: Standard error.
Same alphabetical characters are mutually statistically significant (a, b, c, abc, ad, be, cde, abc).

insufficiency.[11] In the case of high myopia, the results revealed a significant difference in accommodative amplitude, and it was also demonstrated that the symptom of accommodative insufficiency increased with the number of convergence insufficiencies.

The present study shows a significant difference in axial length across different degrees of myopia in a mean age group of 20.24 years. Other studies suggested that age modifies the effect of axial length on visual impairment. There appeared to be a deficiency between the onset of myopia, which often occurs during childhood and adolescence, and the presentation of visual impairment, which primarily happens in middle-aged and elderly persons.[12] Less sample for high degrees of myopia, contrast sensitivity, and stereopsis where the limitation of the study would have been accessed statistically better.

CONCLUSION

The study shows significant changes in visual function in myopic adults. This study notes that visual acuity alone may not be a reliable measure of overall vision quality. Instead, a comprehensive visual function exam should be performed on all patients, as this will likely impact the overall visual quality.

Ethical approval: The research/study approved by the Institutional Review Board at Saveetha College of Allied Health Sciences, number SCAHS/ISRB/2024/March/551, dated 27th March 2024.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent.

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