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Insights Into the Visual and Functional Impactof Astigmatism on Daily Living: A Comprehensive Analysis

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ABSTRACT

Aim: This study aimed to comprehensively analyze the visual and functional impact of astigmatism on daily living.

Methods: The study involved 280 adults aged 18 to 35, undergoing face-to-face interviews for health histories, NEI VFQ questionnaire completion, and refractive condition assessments. Pearson correlation coefficients analyzed associations between domains of NEI VFQ, contrast sensitivity, and visual acuity.

Results: The study encompassed 280 participants aged 18 to 35, predominantly male, showcasing diverse demographics. Ocular health analysis revealed a mean SEq refraction of 1.24 D, with astigmatism prevalence at 41.1%. Strong positive correlations were observed between refractive errors (r = 0.69) and corneal astigmatic errors (r = 0.86), indicating interocular consistency. Contact lens treatment significantly enhanced NEI VFQ scores across various domains, reflecting improved quality of life and visual functioning. Notably, mean scores increased notably for general vision, general health, and ocular pain domains. Correlation analyses between NEI VFQ aspects, visual acuity, and contrast sensitivity revealed nuanced relationships, emphasizing the importance of assessing both parameters for comprehensive evaluation.

Conclusion: This research underscores the substantial impact of astigmatism on daily living, affecting various aspects of visual functioning and quality of life. The findings demonstrate the need for comprehensive evaluation and treatment strategies to reduce the negative impact of astigmatism and enhance visual function and general level of existence.

Keywords: Astigmatism, NEI VFQ Questionnaire, Visual Function, Ocular Health, Quality of Life.

1. INTRODUCTION

Astigmatism is a prevalent refractive abnormality that impacts a substantial proportion of the global population, which leads to impaired vision and hinders the performance of daily activities [1]. This visual impairment is caused by abnormalities in the cornea's or lens's shape, which causes incoming light rays to be distorted. As a consequence, those who have astigmatism often have distorted or blurry vision [2].

Beyond only being inconvenient, astigmatism has a significant impact on many facets of people's life. For instance, reading becomes difficult since the text could be hazy or hard to concentrate on [3]. In a similar vein, driving may be challenging, particularly in circumstances when having clear eyesight is necessary to see road signs and traffic. Astigmatism may compromise depth perception and visual acuity, which may influence performance and perhaps increase the risk of accidents or injuries. As a result, even participation in sports may be impacted [4].

Furthermore, the effects of astigmatism extend beyond social activities and even influence career aspirations [5]. Jobs requiring a high degree of visual acuity, including those in the design, technology, or medical industries, may be quite difficult for those with uncorrected astigmatism. It may be especially difficult to do tasks that call for visual accuracy or close attention to detail, which might impair productivity and general work performance [6].

All things considered, astigmatism may have a significant impact on an individual's standards of life by making it more difficult for them to do regular tasks and reach their professional objectives. It's not simply a minor inconvenience. Astigmatism may be effectively managed and corrected with techniques like refractive surgery or corrective lenses, which can significantly enhance visual acuity restore functioning and allow people to lead more rewarding personal and professional life [7].

2. METHODOLOGY

2.1 Study participants

The study included 280 adult participants. The age range of the participants was from 18 to 35 years. All research participants provided voluntary permission to participate in the study after receiving detailed information about the study's aims, methodologies, and any possible hazards associated with it.

2.2 Data collection

The study's data collection adhered to the guidelines and protocols established by the Institutional Review Board. Conducted in Jaipur, Rajasthan, India, the investigation ensured written informed consent was obtained from each participant before testing.

2.3 Study procedures

The study conducted in-depth face-to-face semi-structured interviews with 280 adults to gather information on their ocular and general health histories, helping to identify potential risk factors. Every participant successfully filled out a questionnaire termed the National Eye Institute Visual Functioning Questionnaire NEI-VFQ 25. The screening procedures involveda series of assessments aimed at providing a comprehensive evaluation of participants' visual health. For the ocular health assessment, refractive measures and prevalence were determined, followed by correlation analysis of refractive error and corneal astigmatic error. Interocular consistency was assessed by differences in refractive error and astigmatism between eyes. In NEI VFQ questionnaire administration, participants completed assessments before and after contact lens treatment to evaluate visual functioning changes. Scoring analysis compared mean scores across NEI VFQ domains before and after treatment, while correlation analysesexplored associations between visual acuity and NEI VFQ aspects, and contrast sensitivity with visual functioning domains.

2.4 Statistical Analysis

The statistical analysis utilized IBM Corp.'s SPSS Version 25.0, employing visual confirmation of normal distribution through box plots and histograms. Parametric statistics were deemed appropriate after confirming data normality. There was an applied significance threshold of $p < 0.05$. Although the possibility of type I errors was recognised during result interpretation, corrections for multiple comparisons were not applied due to the exploratory character of the trials in order to prevent disguising important findings.

3. RESULTS

3.1 Demographic and clinical characteristics:

The study involved a total of 280 individuals, with an average age of 23.92 years. Gender distribution revealed 90 females and 190 males, indicating a predominance of males within the study group. These clinical characteristics offer valuable insights into the demographic makeup of the sample, facilitating a comprehensive understanding of the research cohort's composition.

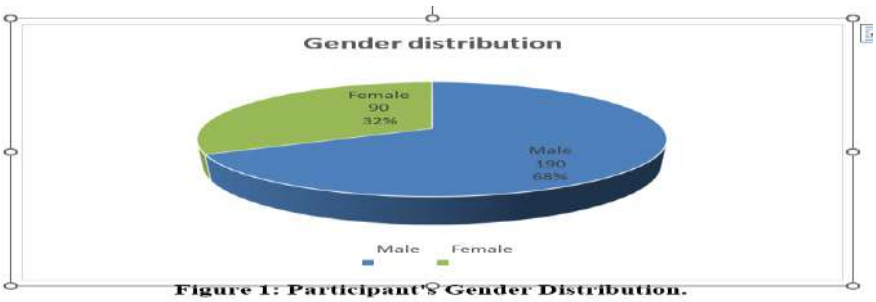

Figure 1: Participant's Gender Distribution.

3.2 Characteristics of Participants in Ocular Health Study

The characteristics of participants in the ocular health study reveal several key findings. The mean right-eye spherical equivalent (SEq) refraction was determined to be 1.24 diopters (D). The prevalence of astigmatism (SEq ≥ +2.00 D) was observed in 41.1% of participants. The Pearson correlation coefficient between right and left refractive error was calculated to be 0.69, indicating a strong positive correlation ($p < 0.0001$). Similarly, the correlation between

right and left corneal astigmatic error was notably high at 0.86 ($p < 0.0001$). The right and left eyes had a negligible variation in mean refractive error, measured 0.01 ± 0.22 D. Likewise, the mean difference in corneal astigmatic error between eyes was also negligible, with a similar value of 0.01 ± 0.22 D. These findings provide valuable insights into the ocular health profile and interocular consistency among the participants in the study (shown in Table 1).

Table 1: Characteristics of Participants in Ocular Health Study

Category	Data
Mean Right-Eye SEq Refraction (D)	1.24
Prevalence of astigmatism (SEq ≥ +2.00 D)	41.1%
Pearson Correlation Right/Left Refractive Error	0.69 ($p < 0.0001$)
Pearson Correlation Right/Left Corneal Astigmatic Error	0.86 ($p < 0.0001$)
Mean Difference Right/Left Eye Refraction (D)	0.01 ± 0.22
Mean Difference Right/Left Eye Corneal Astigmatic Error (D)	0.01 0.22

3.3 Comparison of NEI VFQ Questionnaire Scores Before and After Contact Lens Treatment

The comparison of NEI VFQ questionnaire scores before and after contact lens treatment reveals notable improvements across various aspects of visual functioning. Before treatment, patients reported a range of uncorrected scores, with the lowest scores observed in ocular pain and near activities domains, indicating challenges in these areas. However, after contact lens treatment, substantial increases in mean scores were observed across all domains, indicating enhanced visual functioning and overall satisfaction with treatment. Specifically, patients' mean scores increased from 80.96 to 89.12 for general health, from 37.96 to 91.51 for general vision, and from 45.56 to 63.51 for ocular pain. Improvements were also seen in tasks including driving, social functioning, mental health, career challenges, near and far vision, colour vision, and peripheral vision. Notably, the total mean score increased from 52.11 to 75.63, reflecting a significant overall improvement in patients' quality of life-related to vision following contact lens treatment. These findings highlight the effectiveness of contact lens treatment in enhancing various aspects of visual functioning and improving patients' overall quality of life.

Table 2: Comparison of NEI VFQ Questionnaire Scores Pre- and Post-Contact Lens Treatment

NEI VFQ Questionnaire	Patients' uncorrected Scores before treatment			Patients' scores after contact lens treatment			Standard Deviation P
	Min.	Max.	Mean.	Min.	Max.	Mean.	
General Health	50	100	70.96	74	100	79	0.36
General vision	20	38	37.86	59	100	92	0.00
Ocular pain	24	100	46.56	38	100	64	0.07
Near activities	24	75	42.12	50	100	77	0.00
Distance activities	24	75	48.06	50	100	79	0.02
Visual-specific social functioning	24	75	44.65	50	100	75	0.00
Visual-specific mental health	24	75	64.92	50	100	75	0.20
Visual-specific role difficulties	24	75	60.21	50	100	74	0.0

Visual specific dependency	50	100	67.81	50	100	76	0.28
Driving	50	75	65.62	50	100	78	0.14
Color vision	50	100	61.52	50	100	73	0.22
Peripheral vision	50	100	62.00	50	100	78	0.35
Total	34.22	80.00	52.11	50	100	76	0.00

3.4 Association between visual acuity and contrast sensitivity and the NEI VFQ questionnaire

The correlation between visual acuity (logMAR) and various aspects of visual function, as well as contrast sensitivity, was examined using the NEI VFQ questionnaire. The study found a modest positive association (r = 0.36, p = 0.102) between overall health and contrast sensitivity, but there was no significant association (r = -0.12, p = 0.823) with visual acuity. Corresponding to this, there was no significant association between contrast sensitivity (r = 0.26, p = 0.136) and general vision (r = -0.22, p = 0.078), with the former showing a slight negative correlation. There was a noteworthy positive association (r = 0.89, p = 0.041) between near activities and visual acuity, as well as a substantial correlation (r = 0.78, p = 0.038) between near and contrast sensitivity. In contrast, a moderate positive association was seen with contrast sensitivity (r = 0.51, p = 0.081) and a substantial negative correlation (r = -0.77, p = 0.045) was observed with distance activities. Other domains displayed mixed correlations with visual acuity and contrast sensitivity, suggesting varying impacts on different aspects of visual function. Overall, there were significant correlations between visual acuity and some aspects of visual function, highlighting the importance of assessing both visual acuity and contrast sensitivity in evaluating visual performance.

Table 3: Correlation Assessment: Addressing the causal connection between the NEI VFQ Questionnaire, Visual Acuity, and Contrast Sensitivity.

NEI VFQ questionnaire	Visual acuity (logMAR)		Contrast sensitivity	
	r	P	r	P
General Vision	-0.21	0.075	0.27	0.135
General Health	-0.13	0.822	0.37	0.104
Near activities	0.88	0.042	0.68	0.039
Ocular pain	-0.17	0.342	0.16	0.252
Visual-specific social functioning	-0.46	0.082	0.34	0.142
Distance activities	-0.76	0.044	0.52	0.082
Visual-specific role difficulties	0.12	0.412	0.16	0.225
Visual-specific mental health	0.20	0.142	0.27	0.152
Driving	-0.43	0.081	0.49	0.062
Visual specific dependency	-0.30	0.122	0.17	0.229
Peripheral vision	-0.40	0.065	0.52	0.047
Color vision	-0.37	0.142	0.50	0.052
Total	-0.32	0.072	0.38	0.095

4. DISCUSSION

Astigmatism is a prevalent uncorrected refractive anomaly characterized by asymmetric

curvature of the cornea or lens, leading to significant impairment in both near and distant visual acuity [8]. This qualitative study delved into the impact of astigmatism on individuals' daily activities and functionality. The study demonstrates a comprehensive examination of adult participants' ocular health and visual capabilities. The study establishes a foundation of ethical conduct by including 280 adult participants within a specific age range and ensuring voluntary consent. The utilization of face-to-face semi-structured interviews and the NEI-VFQ 25 questionnaire allows for a comprehensive collection of data regarding ocular and general health histories, enabling the identification of potential risk factors. Furthermore, the screening procedures, including refractive measures, prevalence determination, and correlation analyses, provide detailed insights into participants' visual health profiles.The administration of the NEI VFQ questionnaire before and after contact lens treatment, coupled with scoring and correlation analyses, provides a comprehensive assessment of treatment outcomes and associations between visual acuity, contrast sensitivity, and visual functioning domains. For instance, a study by Harrington S et al., 2022 similarly investigatedocular health and visual functioning among adult participants using standardized questionnaires and assessments [9]. While a previous study by Lamoureux EL et al., 2011 concentrated solely on the effects of age-related macular degeneration (AMD) on visual functioning [10], this research broadens its scope to encompass various ocular health factors and treatments, including contact lens treatment. This expansion offers a more comprehensive insight into visual health and treatment outcomes, extending beyond the confines of a single condition like AMD. Additionally, this study aligns with the best practices recommended byVinas M et al., 2011[11]. Wu W et al., 2024 emphasize the importance of thorough data collection methods, including both quantitative and qualitative measures, to capture the multifaceted nature of visual health [12]. The study adheres to this recommendation by incorporating semi-structured interviews alongside standardized questionnaires, allowing for a nuanced exploration of participants' ocular and general health histories.

Furthermore, the statistical analysis approach employed in the study, utilizing SPSS Version 25.0 and visual confirmation of normal distribution, aligns with Parmar KR et al., 2022 [13]. By ensuring data normality and applying appropriate parametric statistics, the study enhances the reliability and validity of its findings. However, unlike some previous studies that have adjusted for multiple comparisons to mitigate type I errors, this study acknowledges the potential for such errors during result interpretation. This decision, informed by the exploratory nature of the experiments, allows for more transparent reporting of significant results while acknowledging the limitations inherent in multiple comparisons.

5. CONCLUSION

The research findings highlight significant insights into both the demographic and clinical characteristics of the study participants and the effectiveness of contact lens treatment in enhancing various aspects of visual functioning. The demographic analysis reveals a diverse age range and a predominance of male participants within the cohort. Regarding ocular health, the prevalence of astigmatism, along with strong correlations between refractive errors and interocular consistency, elucidates important patterns in visual health. Furthermore, the comparison of NEI VFQ questionnaire scores before and after contact lens treatment demonstrates substantial improvements across multiple domains, indicating enhanced visual functioning and overall satisfaction with treatment. Correlation analyses between NEI VFQ aspects, visual acuity, and contrast sensitivity underscore the interconnectedness of these factors in evaluating visual performance. Future research could explore longitudinal outcomes of contact lens treatment and investigate interventions to address specific areas of visual functioning, contributing further to the understanding and improvement of ocular health and quality of life.

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