Original Research Article

**Prevalence of Non-Strabismic Binocular Vision Anomalies in Myopic and Hypermetropic Young Adults: A Cross-Sectional Study**

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ABSTRACT

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| **Aim***:* To assess the Non-Strabismic Binocular Vision Anomalies among Myopic and Hypermetropic young adults.  **Methodology:** **The** Prospective, cross-sectional study was conducted to assess the NSBVA among 55 myopic and 55 hypermetropic patients. The study protocol was approved by the Institutional Ethical Committee. The study included total 110 patients aged 10 to 35 years, 55 diagnosed with myopia and 55 patients with hypermetropia. Recruited participants undergone comprehensive ocular examination along with binocular vision assessment. Diagnosis of NSBVA was based on normative data and diagnostic criteria mentioned in the Scheiman and Wicks findings. Data was analyzed using IBM SPSS 23.0.  **Results: Of total 110 patients, 44 (40%) had normal binocular function while 60% were diagnosed with NSBVAs. Most common NSBVA reported was convergence insufficiency 20 (18.2%) followed by convergence excess 15 (13.6%), accommodative excess and insufficiency 12(11.8%) and divergence insufficiency 5 (4.5%).** Convergence insufficiency was the most common anomaly among the myopic group, identified in 14 (25.4%) patients and convergence excess was far more prevalent in the hypermetropic group, affecting 12 (21.8%) individuals.  **Conclusion***:* The study established that NSBVA and refractive errors are interlinked. Myopic patient had higher prevalence of NSBVA than hypermetropes but the difference was not significant. Hypermetropic patients are more prone to convergence excess followed by accommodative excess and insufficiency, while myopic individuals exhibit a higher prevalence of convergence insufficiency. Clinicians should consider comprehensive binocular vision testing in patients presenting with asthenopic symptoms, irrespective of their refractive status. Early identification and management of NSBVAs can significantly improve visual comfort and quality of life. |

***Keywords:*** *Accommodation, Asthenopia, Binocular Vision Anomalies, Convergence, Hypermetropia, Myopia, Vergence dysfunction*

1. INTRODUCTION

Binocular vision is the ability of both eyes to work together to achieve a single, clear, and comfortable image. Any disruption in this coordination can lead to binocular vision anomalies, which may be either strabismic or non-strabismic. Non-strabismic binocular vision anomalies (NSBVAs) refer to a range of conditions where the eyes are properly aligned, but problems exist in the vergence and accommodative systems. Common NSBVAs include convergence insufficiency, convergence excess, divergence insufficiency, divergence excess, and various accommodative disorders. These anomalies can significantly affect visual performance, especially in tasks requiring sustained near work, such as reading and writing.[1,2,3] Refractive errors like myopia (nearsightedness) and hypermetropia (farsightedness) are prevalent visual conditions known to influence binocular vision. In myopic individuals, the reduced accommodative demand may alter the balance of the accommodative-convergence system, potentially resulting in vergence dysfunctions such as convergence insufficiency.[1] On the other hand, hypermetropic individuals often exert greater accommodative effort to maintain clear vision, which may predispose them to convergence excess or accommodative excess. Understanding the interaction between refractive errors and NSBVAs is essential for accurate diagnosis and effective management of visual complaints.[4] Several studies have examined the prevalence and nature of NSBVAs in individuals with refractive errors, yet findings remain varied. Some research suggests that convergence insufficiency is more commonly associated with myopia, while others report a higher incidence of accommodative dysfunctions among hypermetropes. Despite these findings, there is still a need for further research to clarify these associations and improve clinical outcomes through targeted interventions. This study aims to investigate the non-strabismic binocular vision anomalies among myopic and hypermetropic patients. The findings will provide insights into the patterns of NSBVAs in these refractive groups, contributing to better clinical assessment and patient care strategies.

2. material and methods

**The** cross-sectional, clinical study was conducted to assess the association between non-strabismic binocular vision anomalies among myopic and hypermetropic patients. The study protocol was approved by the Institutional Ethical Committee. The study included total 110 patients aged 10 to 35 years who attended the outpatient department of a tertiary eye care center. Participants were divided into two groups: 55 myopic patients and 55 hypermetropic patients based on their refractive status determined through subjective and objective refraction. The patients with presence of manifest strabismus or Amblyopia, history of ocular surgery, trauma, or systemic neurological disease & any media opacity affecting vision or ocular motility disorders has been excluded from the study. Diagnostic criteria for accommodative and vergence anomalies was in accordance to the Scheiman and Wick.[1] Details of participants and their identities were kept confidential. Participants underwent a comprehensive eye examination which included:

1. **Refractive Assessment:**
   * Objective refraction using cycloplegic retinoscopy
   * Subjective refraction to determine the final prescription
2. **Binocular Vision Evaluation:**
   * Cover test at distance and near to rule out Phoria/tropia
   * Near point of convergence (NPC).
   * Positive and negative fusional vergence (PFV/NFV) at distance and near
   * Amplitude of accommodation (AA).
   * Monocular Accommodative facility using ±2.00D flipper lenses.

**Data Analysis:** Data were entered in Microsoft Excel and analyzed using IBM SPSS 23.0 (IBM, Armonk, New York, USA). Descriptive statistics were used to summarize demographic data and prevalence of NSBVAs. Independent T test was applied to compare the various binocular vision anomalies among myopia and hypermetropia group. A p-value of <0.05 was considered statistically significant.

3. results

A total of 110 patients were enrolled, with 55 (50%) being myopic and 55 (50%) hypermetropic. The mean age of participants was 22.4 ± 5.6 years. Of total 110 participants, 58 (52.7%) were females and 52 (47.3%) were males as shown in Figure 1.

**Figure 1 Gender distribution of participants**

**Mean Spherical equivalent of hypermetropia was +2.54±1.021 D and myopia was -1.65±2.21 D. Of total 110 patients, 44 (40%) had normal binocular function while 60% were diagnosed with non Strabismic binocular vision anomalies. Most common non Strabismic binocular vision anomalies reported was convergence insufficiency 20 (18.2%) followed by convergence excess 15 (13.6%), accommodative excess and insufficiency 12(11.8%) and divergence insufficiency 5 (4.5%) as depicted in** Table 1**.**

**Table 1 Prevalence of Non-Strabismic Binocular Vision Anomalies (NSBVAs) among patient with different refractive error**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.N** | **Type of Anomaly** | **N** | **%** |
|  | Convergence Insufficiency | 20 | 18.2 |
|  | Convergence Excess | 15 | 13.6 |
|  | Divergence Insufficiency | 5 | 4.5 |
|  | Accommodative Insufficiency | 13 | 11.8 |
|  | Accommodative Excess | 13 | 11.8 |
|  | Normal Binocular Function | 44 | 40 |
|  | Total | 110 | 100 |

**Table 2 Non-Strabismic Binocular Vision Anomalies (NSBVAs) among myopic patients**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.N** | **Type of Anomaly** | **Myopia** | | **Hypermetropia** | |
| **(n=55)** | **%** | **(n=55)** | **%** |
|  | Convergence Insufficiency | 14 | 25.4 | 6 | 10.9 |
|  | Convergence Excess | 3 | 5.4 | 12 | 21.8 |
|  | Divergence Insufficiency | 2 | 3.6 | 3 | 5.4 |
|  | Accommodative Insufficiency | 5 | 9.1 | 8 | 14.5 |
|  | Accommodative Excess | 4 | 7.3 | 9 | 16.3 |
|  | Normal Binocular Function | 27 | 49.1 | 17 | 30.9 |

**Convergence Insufficiency (CI)**

Convergence insufficiency was the most common anomaly among the myopic group, identified in 14 (25.4%) patients. This condition is characterized by a reduced ability to maintain convergence at near, often resulting in symptoms like eye strain and blurred near vision. In contrast, only 6 (10.9%) hypermetropic patients exhibited this anomaly. This supports the literature that myopes, who exert minimal accommodative effort at near, are more susceptible to CI due to lower accommodative-convergence stimulus.

**Convergence Excess (CE)**

Conversely, convergence excess was far more prevalent in the hypermetropic group, affecting 12 (21.8%) individuals compared to only 3 (5.4%) myopic patients. This finding aligns with the increased accommodative effort in hypermetropes during near tasks, leading to excessive convergence and often resulting in esophoric tendencies. This makes CE a significant NSBVA subtype among hypermetropic individuals.

**Divergence Insufficiency (DI)**

This anomaly was relatively rare in both groups but slightly more frequent in hypermetropes. It was found in 2 (3.6%) myopic patients and 3 (5.4%) hypermetropic patients. Divergence insufficiency typically manifests as difficulty maintaining single vision at distance, and its presence in both groups.

**Accommodative Insufficiency (AI)**

Accommodative insufficiency, where the eyes have difficulty sustaining focus at near, was found in 5 (9.1%) myopic patients and 8 (14.5%) hypermetropic patients. This slightly higher prevalence among hypermetropes may be due to increased accommodative fatigue caused by chronic overuse of the accommodative system to overcome their refractive error.

**Accommodative Excess (AE)**

Accommodative excess, or difficulty in relaxing accommodation, was also more common in hypermetropes 9 (16.3%) compared to myopes 4 (7.3%). This condition is frequently associated with patients who habitually over-accommodate, again suggesting a pattern related to the refractive demand in hypermetropia.

**Normal Binocular Vision**

Interestingly, a significantly higher proportion of myopic patients 27 (49.1%) exhibited normal binocular function compared to hypermetropes 17 (30.9%). This suggests that myopic individuals, despite being prone to certain specific NSBVAs, may overall have a more stable binocular system than hypermetropes, who are under greater strain due to the accommodative demands imposed by their refractive status.

The findings of this study suggests that there is no significant difference in the prevalence between the Non-Strabismic Binocular Vision Anomalies (NSBVAs) among myopic and hypermetropic patients (p=0.635) as shown in Table 3.

**Table 3 Comparison of Non-Strabismic Binocular Vision Anomalies (NSBVAs) among myopic and hypermetropic patients**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.N** | **Type of Anomaly** | **Myopic (n=55)** | **Hypermetropic (n=55)** | **t-value** | **p-value** |
|  | Convergence Insufficiency | 14 | 6 | 0.476 | 0.635 |
|  | Convergence Excess | 3 | 12 |
|  | Divergence Insufficiency | 2 | 3 |
|  | Accommodative Insufficiency | 5 | 8 |
|  | Accommodative Excess | 4 | 9 |
|  | Normal Binocular Function | 27 | 17 |

4. Discussion:

The data from this study underscore a statistically insignificant difference in the distribution of non-strabismic binocular vision anomalies (NSBVAs) between myopic and hypermetropic individuals. Overall prevalence of NSBVA was 60% which was higher compared to the previous study conducted by Varshney AS which showed 30% prevalence rate of NSBVA. Another study conducted by Shongmu TL et. al reported the prevalence of NSBVA as 62.2% which follow the similar trend to this study. The greater proportion of hypermetropic patients (69.1%) exhibited NSBVAs compared to their myopic counterparts (50.9%). [5,6] This finding aligns with the premise that hypermetropia, due to its higher accommodative demand, predisposes patients to anomalies like convergence excess and accommodative excess.

**Convergence Insufficiency** was the most common NSBVA among myopic patients, affecting 25.4% compared to 10.9% in hypermetropes. This is consistent with the reduced need for accommodation in myopes during near work, which in turn reduces accommodative convergence, leading to a relative exophoric posture. This finding supports earlier reports by Rouse et al. (1998) and Scheiman et al. (2020), who identified convergence insufficiency as more prevalent among individuals with myopia.[1,7]

**Convergence Excess**, on the other hand, was more prevalent in hypermetropes (21.8%) than in myopes (5.4%). This likely reflects the increased accommodative-convergence ratio in hypermetropes, who must exert greater accommodation for near tasks, thereby inducing excess convergence. This imbalance often results in symptoms such as near vision blur, diplopia, or headaches.[1]

**Divergence Insufficiency** was relatively rare, with marginally higher prevalence in hypermetropes (5.4%) than in myopes (3.6%). A known risk factor for DI is uncorrected hyperopia, which causes excessive accommodative-convergence, which might lessen divergence tone.[8] It has been demonstrated that correcting children's even low hyperopia (+0.50 D to +2.25 D) improves binocular performance, indicating that hyperopic refractive error has an essential role in controlling divergence (and convergence).[9]

**Accommodative Insufficiency** and **Accommodative Excess** were both more prevalent in hypermetropic patients (14.5% and 16.3% respectively) compared to myopes (9.1% and 7.3%). This reflects the hypermetropes’ need to sustain a higher level of accommodation to achieve clear near vision, potentially exhausting the accommodative system or leading to overexertion. Marran et al. (2006) noted a similar trend, indicating that accommodative anomalies are a common comorbidity in patients with refractive error-related binocular dysfunction. [10] Another study conducted by Rani A et al. (2025) found that accommodative insufficiency (30..88%) was the common NSBVA found among hypermetropic patients.[11]

Notably, **Normal Binocular Function** was observed in nearly half of myopic participants (49.1%) but only in 30.9% of hypermetropic participants. This suggests that myopic individuals, despite their refractive status, are less likely to suffer from symptomatic binocular dysfunction. This finding emphasizes the importance of detailed binocular vision assessments particularly in hypermetropic patients, even when refractive correction appears adequate.[12]

The high proportion of anomalies in both groups also reinforces the need for clinicians to incorporate binocular vision evaluation into standard optometric exams. While refractive correction may alleviate some symptoms, uncorrected NSBVAs can continue to impact the patient’s quality of life and visual efficiency.

**5. CONCLUSION**

The study established that non-strabismic binocular vision anomalies and refractive errors are interlinked. The NSBVA are more prevalent in myopia compared to the hypermetropia bot the difference was insignificant. Hypermetropic patients are more prone to convergence excess followed by accommodative excess and insufficiency, while myopic individuals exhibit a higher prevalence of convergence insufficiency. Clinicians should consider comprehensive binocular vision testing in patients presenting with asthenopic symptoms, irrespective of their refractive status. Early identification and management of NSBVAs can significantly improve visual comfort and quality of life.

Ethical approval

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

Consent:

Written informed consent was obtained from all participants. The confidentiality of participants was maintained throughout the study.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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