International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

A Comparative Study of Heterophoria in Young Adults with Emmetropic and Myopic Refractive Errors

Priyanka Roy

Assistant Professor, Haldia Institute of Management

Abstract: ***This study aimed to explore the relationship between heterophoria (a type of eye alignment imbalance) and refractive error (such as myopia or emmetropia) in young adults. A total of 40 participants took part in the study, including 13 individuals with myopia and 27with emmetropia (normal vision without the need for correction). Heterophoria was assessed using the Free - Space Phoria Card at five different viewing distances: 25 cm, 33 cm, 50 cm, 100 cm, and 300 cm. Across all participants, regardless of whether their heterophoria was esophoric or exophoric, the magnitude of deviation tended to decrease and approach orthophoria (neutral alignment) as the viewing distance increased.***

Keywords: Heterophoria, Myopia, Refractive Errors, Exophoria

1. Introduction

Heterophoria refers to the natural tendency of the two eyes to drift away from their normal alignment when there is no stimulus to maintain fusion (the coordination of both eyes working together). Specifically, exophoria is the condition where the eyes tend to turn outward, while esophoria is when the eyes turn inward, both occurring when the fusion mechanism is temporarily suspended.

Research has thoroughly documented the characteristics of heterophoria at both near and distant viewing distances. Generally, at a distance, many individuals exhibit orthophoria (normal eye alignment), while at near distances, exophoria is more commonly observed, typically within a range of 0 to 4 prism diopters.

The degree of heterophoria can vary depending on the viewing distance. For example, distance phoria has been shown to differ from tonic vergence due to factors like accommodative divergence. A predictive model for distance phoria considers elements such as negative accommodation, accommodative vergence, and dark vergence, with the formula:

Regarding refractive states, emmetropia (normal vision) and myopia (nearsightedness) are two key eye conditions. In emmetropia, light from distant objects is focused directly on the retina when the eye is in a relaxed state. In myopia, however, the light is focused in front of the retina when the eye is relaxed, leading to blurred distant vision.

Previous studies have identified a significant association between heterophoria and the development of myopia. In particular, near - point esophoria has been closely linked to the progression of myopia during childhood. Research also indicates that individuals with late - onset myopia tend to exhibit higher average accommodative convergence to accommodation (AC/A) ratios and elevated dark vergence values, alongside lower average dark focus measurements, when compared to individuals who remain emmetropic. The present study aims to explore the variations in heterophoria across different viewing distances in individuals with myopia compared to those with emmetropia.

2. Materials and Methods

A total of 40 college going students, aged between 18 to 22 years, were recruited to participate in this study. All participants had undergone a comprehensive optometric evaluation within the past seven days and exhibited no clinical signs of accommodative dysfunction, binocular fusion anomalies, stereopsis impairment, or strabismus. Informed written consent was obtained from each participant prior to data collection.

The myopic group consisted of 13 students (9 females and 4 males) with spherical refractive errors ranging from - 0.25 diopters sphere (DS) to - 5.00 DS and cylindrical corrections between - 0.25 diopters cylinder (DC) and - 1.00 DC. The emmetropic group included 27 students (15 females and 12 males), whose refractive status ranged from plano to +0.50 DS. Notably, the majority of myopic participants (11 out of 13) reported early - onset myopia, with onset occurring before the age of 16. All participants had corrected visual acuity of 6/6 or better in each eye.

Visual Acuity and Measurement Method

All participants had a best - corrected visual acuity of 6/6 to 6/9 or better in both eyes. To assess heterophoria, the Free - Space Phoria Card was used (Figure 1). This tool is specifically designed to enhance accommodative accuracy and reduce fusion, making it suitable for reliable phoria measurements. The original card was adapted into five different sizes, each calibrated for a specific testing distance: 25 cm, 33 cm, 50 cm, 100 cm, and 300 cm. These modifications ensured that the visual angle of the key elements on the card—including the numbers, arrow, and bar width—remained constant at 13 minutes of arc, regardless of distance. The optotype heights for each distance were set at 0.95 mm, 1.25 mm, 1.89 mm, 3.78 mm, and 11.36 mm respectively.

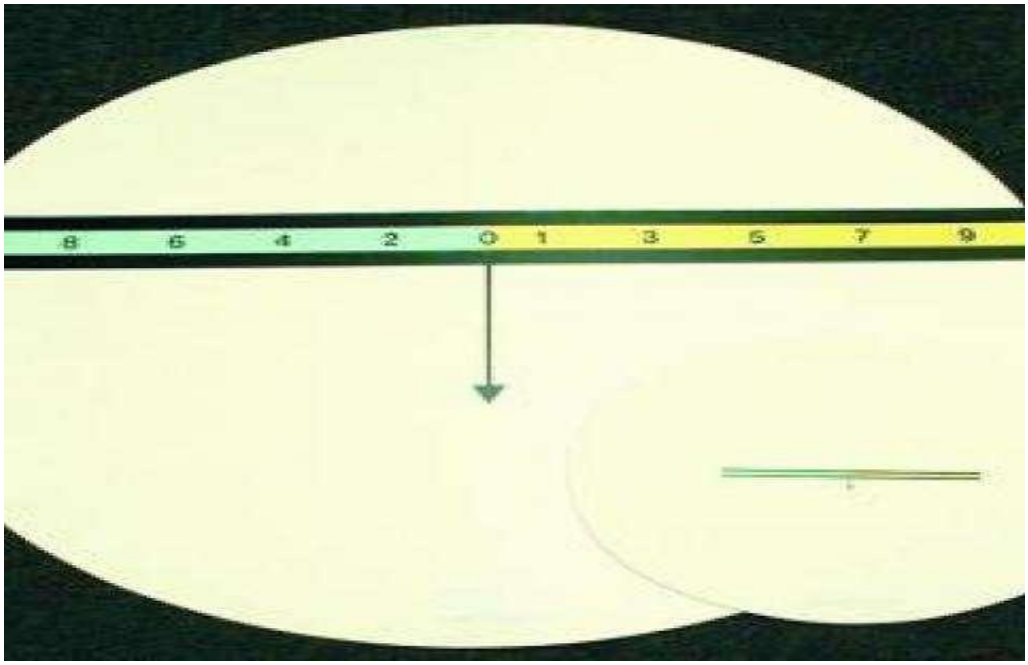

Figure 1: Free space phoria card

During testing, an 8 prism diopter base - down prism was placed in front of the subject's right eye. This caused the horizontal number line on the oval - shaped card to split into two vertically separated lines. The arrow from the top line pointed to a number on the bottom line, indicating the immediate heterophoria value.

To minimize the influence of proximal cues, the examiner held the card at each testing distance. Given that some individuals may develop a shift toward esophoria with prolonged fixation, alternate occlusion was incorporated into the testing protocol. The participant was asked to report the position of the arrow immediately after the occluder was removed from the right eye. This procedure was repeated multiple times (with each measurement lasting under 30 seconds), and the average of two readings was recorded for each distance. Each testing distance was assessed in a randomized sequence, and binocular fusion was allowed between measurements. The entire phoria assessment for all five distances took less than five minutes per participant.

3. Results

Out of the 40participants, 27 individuals (approximately 67%) exhibited exophoria at all five testing distances. The remaining 13 participants (33%) showed a combination of exophoria and esophoria depending on the viewing distance. In this subgroup, most had mild esophoria at far distances and moderate to significant exophoria at near distances.

Table 1

Types of Refractive Error	300cm	100cm	50cm	33cm	25cm
Emmetropia	- 0.90±1.80	- 1.89±2.18	- 2.59±2.52	- 3.96±3.02	- 6.27±4.12
Myopia	- 0.87±1.53	- 1.60±2.09	- 1.96±2.37	- 2.28±3.05	- 5.51±3.03

Table 1 summarizes the mean heterophoria values and standard deviations for both emmetropic and myopic participants across the five test distances. Overall, heterophoria tended to move closer to orthophoria (neutral alignment) as the viewing distance increased in both groups.

4. Results and Analysis

The overall difference in heterophoria between myopic and emmetropic participants was not statistically significant ($F = 0.30$, $p > 0.05$). However, greater variability in heterophoria measurements was observed at closer viewing distances. While most participants demonstrated alignment close to orthophoria (neutral eye posture) when viewing distant targets, their heterophoria responses at near distances varied widely—some showing esophoria (inward deviation) and others exophoria (outward deviation). The magnitude of these deviations also tended to increase as the viewing distance decreased.

This trend is clinically relevant, as near - point exophoria has been associated with greater visual comfort and stability during close work, acting as a buffer against near - point stress. In contrast, near - point esophoria has been linked to visual strain and is considered a risk factor for myopia progression.

To explore this further, participants were divided into two groups based on their heterophoria patterns:

- **Exophores**: Individuals who exhibited only exophoria at all test distances.
- **Non - exophores**: Those who showed either a mix of esophoria and exophoria or consistent esophoria.

Table 2

Types of Phoria	300cm	100cm	50cm	33cm	25cm
Exophoria	- 1.44± 1.51	- 2.47 ± 2.12	- 3.43 ± 2.11	- 4.63 ± 2.56	- 7.39 ± 3.16
Non exophoria	- 0.37 ± 1.49	- 0.28 ± 1.28	- 0.06 ± 1.34	- 0.76 ± 2.46	- 2.96 ± 3.37

Table 2 presents the mean heterophoria values and standard deviations for both groups. The difference in heterophoria between exophores and non - exophores was statistically significant ($F = 7.04$, $p < 0.05$). Among emmetropes, 72% were classified as exophores and 28% as non - exophores. Similarly, 64% of the myopes were exophores, while 36% fell into the non - exophore category. Despite this numerical difference, the distribution of exophores and non - exophores between myopes and emmetropes was not statistically significant ($\chi^2 = 2.00$, $p > 0.05$).

When heterophoria was plotted against **viewing distance in centimeters**, a **logarithmic** trend was observed: heterophoria increased as the viewing distance decreased. However, when viewing distance was converted to **diopters**, the relationship became **linear**, with a negative slope for both groups. Figures 2 and 3 illustrate these changes for exophores and non - exophores, respectively. The linear regression models were as follows:

Exophores:
$y = -1.51x - 0.74$ ($R^2 = 0.95$)

Non - exophores:
$y = -0.71x - 1.40$ ($R^2 = 0.74$)

In these equations, x represents the viewing demand in diopters, and y represents the heterophoria in prism diopters. The steeper slope for exophores suggests a more pronounced shift in heterophoria with increasing viewing demand. On average, the rate of heterophoria change for exophores (1.51 prism diopters per diopter) was nearly double that of non - exophores (0.71 prism diopters per diopter). However, this difference in slope was not statistically significant ($t = 0.14$, $df = 32$, $p > 0.05$).

5. Discussion

The findings of this study indicate that **exophoria was the most common type of heterophoria**, observed in approximately 69% of participants. Regardless of refractive status or group classification, heterophoria generally shifted toward orthophoria as viewing distance increased. This pattern aligns with previous research on fixation disparity at varying distances.

These results emphasize the importance of understanding individual variations in binocular alignment, especially at near distances, where visual demand is high and the risk of ocular stress or myopia progression may increase.

It is report an exo - shift of the heterophoria with decreasing viewing distance in 97% of our subjects. One subject however showed an eso - shift for closer distance. Although near - point exophoria has been associated with visual stability, where it acts as a buffer to the near point stress to preserve emmetropization, and near - point esophoria with visual deterioration such as faster myopia progression, our finding did not show any significant difference between myopes (early onset myopia) and emmetropes in the type or the degree of heterophoria for all testing distances. However, further investigations of the heterophoria at different distances in young progressive myopes might reveal different results. Meanwhile, hyperopia and exophoria had been described as buffers for emmetropization, where the absorption of both hyperopia and exophoria might be an early sign of near - point stress induced vision disorder or myopia progression. A further study to compare the heterophoria changes with viewing distances between symptomatic and asymptomatic patients might be useful. There is a possible different pattern of heterophoria changes with viewing distances between symptomatic and asymptomatic patients because symptomatic and asymptomatic subjects (eg: asthenopia) had been reported to behave differently in tonic adaptation and in transient myopic shift performance. This additional information on the changing pattern of heterophoria with viewing distance might be useful in the diagnosis and management of non strabismic binocular problems such as divergent excess, convergence weakness and so on.

References

[1] Jang JU, Park IJ, Jang JY. The distribution of near point of convergence, near horizontal heterophoria, and near vergence among myopic children in South Korea. Taiwan J Ophthalmol.2016; 6 (4): 187–92. https: //doi. org/10.1016/j. tjo.2016.07.001

[2] Alrasheed SH, Aldakhil S. Comparison of measured fusional vergence amplitudes using prism bar and synoptophore in Sudanese patients with near exophoria. Open Ophthalmol J.2022; 16 (1): e187436412209301. https: //doi. org/10.2174/18743641 - v16 - e2209301

[3] Lança CC, Rowe FJ. Measurement of fusional vergence: A systematic review. Strabismus.2019; 27 (2): 88–113. https: //doi. org/10.1080/09273972.2019.1583675

[4] Chen AH, O'Leary DJ, Howell ER. Near visual function in young children. Part I: Near point of convergence. Part II: Amplitude of accommodation. Part III: Near heterophoria. Ophthalmic Physiol Opt.2000; 20 (3): 185e198. https: //doi. org/10.1046/j.1475 - 1313.2000.00498. x

[5] Wu KH, Tsai FJ, Li TC, Tsai CH, Peng CT, Wang TR. Normal values of inner canthal distance, interpupillary distance and palpebral fissure length in normal Chinese children in Taiwan. Acta Paediatr Taiwan.2000; 41 (1): 22–27.

[6] Ditmars DL. Relationship between refractive error, phoria, and interpupillary distance in 500 patients. J Am Optom Assoc.1966; 37 (4): 361–363.

[7] Walline JJ, Mutti DO, Zadnik K, Jones LA. Development of phoria in children. Optom Vis Sci.1998; 75 (8): 605–610. https: //doi. org/10.1097/00006324 - 199808000 - 00026

[8] Macfarlane DJ, Fitzgerald WJ, Stark DJ. The prevalence of ocular disorders in 1000 Queensland primary schoolchildren. Aust NZ J Ophthalmol.1987; 15 (3): 161–174. https: //doi. org/10.1111/j.1442 - 9071.1987. tb00066. x

[9] Lam SR, LaRoche GR, De Becker I, Macpherson H. The range and variability of ophthalmological parameters in normal children aged 4 1/2 to 5 1/2 years. J Pediatr Ophthalmol Strabismus.1996; 33 (5): 251–256. https: //doi. org/10.3928/0191 - 3913 - 19960901 - 10