E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.48047/ijprt/16.02.172

Research Article

Accommodation and Vergence in Young Adults with Myopic Anisometropia

Dr. Momina F[1], Dr. Najeeha Shukri[2*], Sandip Kumar[3], Niraj Chaudhary[4]

[1]MBBS, Junior Resident (Year 3), Department of Ophthalmology, Sapthagiri Institute of Medical Sciences and Research Centre, Bangalore, Karnataka, India
[2*]MBBS, DNB, Assistant Professor, Department of Ophthalmology, Sapthagiri Institute of Medical Sciences and Research Centre, Bangalore, Karnataka, India
[3,4]Bachelor of Optometry, Department of Ophthalmology, Sapthagiri Institute of Medical Sciences and Research Centre, Bangalore, Karnataka, India
Email: [1]mominaophthal23@simsrc.edu.in, [2*]drnajeehashukri@gmail.com,[3]aryansandip65@gmail.com, [4]nirajchaudhary2057@gmail.com
Corresponding Author: Dr. Najeeha Shukri
Assistant Professor, Department of Ophthalmology, Sapthagiri Institute of Medical Sciences and Research Centre, Bangalore, Karnataka, India.
Email: drnajeehashukri@gmail.com
Received: 16.05.2026, Revised: 24.06.2026, Accepted: 01.07.2026

ABSTRACT

Background: Myopia is a common refractive error, and anisometropia may impair binocular vision due to unequal refractive status between the eyes. This study compared binocular vision parameters in young adults with isometropic and anisometropic myopia.

Methods: A comparative cross-sectional study was conducted on 75 young adults divided into three groups (n = 25 each). Binocular vision assessment included NPA, NRA, PRA, accommodative facility, MEM, NPC, fusional vergence, vergence facility, AC/A ratio, phoria, and stereopsis. Intergroup comparisons were performed using median ± IQR values.

Results: NPA and NRA were significantly reduced in anisometropia compared to isometropia ($p < 0.001$), while PRA showed no significant difference. Accommodative facility, MEM, NPC, vergence facility, and positive fusional vergence were significantly reduced in anisometropia ($p<0.05$). Stereopsis was poorer in compound anisometropia, whereas NFV, AC/A ratio, and phoria showed no significant differences.

Conclusion: Myopic anisometropia, particularly compound type, is associated with reduced accommodative amplitude, positive fusional vergence, vergence facility, and stereopsis in young adults.

Keywords: Myopia, Anisometropia, Binocular Vision, Amplitude of Accommodation, Relative Accommodation, Accommodative Facility, Positive Fusional Vergence, Near Point of Convergence, Stereopsis, Young Adults.

INTRODUCTION

Myopic anisometropia is defined as an interocular difference in spherical equivalent of ≥1.00 D.[3] It can lead to diplopia, aniseikonia, reduced stereopsis, and asthenopia due to unequal binocular input. It is also associated with accommodative esotropia and amblyopia, although the exact causal relationship remains unclear.[4,5] Increasing age and higher refractive errors have been shown to correlate with anisometropia.[6]

Anisometropia may induce aniseikonia, where the binocular system can compensate for up to 3% retinal image size difference, while differences greater than 5% may impair stereopsis.[7] Its prevalence tends to decrease in infancy but increases during childhood and later life.[3]

Accommodation and convergence have been implicated in myopia development and progression, although their relationship remains complex.[8,9] Limited studies have examined binocular vision differences between isometropic and anisometropic myopia. Therefore, this study aims to evaluate binocular vision components-accommodation, vergence, sensory, and motor functions-in young adults with simple and compound myopic anisometropia compared with myopic isometropia.

MATERIALS AND METHODS

The study was conducted in the Department of Ophthalmology, SIMS & RC Bangalore from March 2024-September 2024. A total of 75 Myopic Anisometropic subjects were enrolled based on the inclusion/exclusion criteria. Ethical clearance was received from the Institutional Ethics Committee before starting the study.

INCLUSION CRITERIA

Participants belonging to age group18-25 years, having Myopic Anisometropia (Mild to moderate), Best corrected visual acuity 6/6, N6, willing to give written informed consent.

EXCLUSION CRITERIA

Participants other than myopic anisometropia, any ocular pathological condition, systemic disease, underwent any ocular surgery, or under medication.

All eligible participants underwent a standardized evaluation protocol. A detailed case history including demographic details, ocular and systemic history, family history, and presenting complaints was recorded. Distance and near visual acuity were assessed under standardized conditions. Binocular vision assessment included sensory evaluation (stereopsis, colour vision, and binocular sensory status) and motor examination for ocular motility and alignment.

Accommodative function was evaluated using amplitude of accommodation, relative accommodation, accommodative facility, and accommodative response at near. Vergence parameters assessed included near point of convergence, fusional vergence amplitudes, vergence facility, and AC/A ratio (gradient method). Phoria was measured at distance and near. All tests were performed under standardized illumination and working distances, with key measurements repeated to obtain reliable averages. Data were recorded in Microsoft Excel and analyzed using SPSS version 26.0.

RESULT

(Table.1) showed a statistically significant difference was observed across the three study groups for multiple accommodative, vergence, and sensory parameters.

Binocular near point of accommodation (NPA) and negative relative accommodation (NRA) were significantly reduced in anisometropic groups compared to myopic isometropia ($p < 0.001$), indicating compromised accommodative relaxation ability. However, positive relative accommodation (PRA) did not differ significantly among groups, suggesting preserved accommodative stimulation capacity despite refractive asymmetry.

Dynamic accommodative response assessed by MEM retinoscopy and accommodative facility also showed significant intergroup differences ($p<0.05$), reflecting altered accommodative dynamics in anisometropia.

Vergence parameters, including near point of convergence (NPC), positive fusional vergence (PFV), and vergence facility, were significantly reduced in anisometropic individuals ($p < 0.001$), demonstrating reduced binocular motor efficiency.

Sensory evaluation revealed that stereopsis was optimal in myopic isometropia and poorest in compound myopic anisometropia. In contrast, AC/A ratio and phoria did not show statistically significant variation, indicating that baseline alignment and accommodative convergence relationship remain relatively unaffected.

Among all groups, compound myopic anisometropia exhibited the most pronounced binocular vision impairment, highlighting the impact of increasing refractive asymmetry.

(Table.2) Amplitude of accommodation showed highly significant variation across the groups ($p < 0.001$).

Monocular NPA (OD and OS) was highest in myopic isometropia (11 ± 1.5 D and 11 ± 0.5 D), reflecting normal accommodative capacity. In contrast, compound myopic anisometropia demonstrated markedly reduced values (4 ± 1 D in both eyes), indicating significant accommodative insufficiency.

Simple anisometropia showed intermediate values with greater variability, suggesting inconsistent accommodative performance within this group.

Binocular NPA (OU) was also significantly reduced in anisometropic groups (4 ± 1 D) compared to myopic isometropia (9 ± 1.5 D), further confirming diminished accommodative amplitude, particularly in compound anisometropia.

(Table. 3) Negative relative accommodation (NRA) showed a statistically significant reduction across groups (p < 0.001), with the lowest values observed in compound anisometropia, followed by simple anisometropia, and highest in isometropia. This indicates reduced ability to relax accommodation in anisometropic individuals.

In contrast, positive relative accommodation (PRA) did not differ significantly (p = 0.064), suggesting that accommodative stimulation remains relatively preserved regardless of refractive status.

(Table. 4) Accommodative facility (AF) demonstrated significant intergroup differences. Monocular AF (OD and OS) was highest in myopic isometropia and significantly reduced in both simple and compound anisometropia (p < 0.001 and p = 0.002, respectively). Similarly, binocular AF was significantly lower in compound anisometropia (p < 0.001), indicating reduced flexibility of the accommodative system.

MEM findings also showed significant variation (p = 0.025), with higher lag observed in myopic isometropia. This suggests differences in accommodative response accuracy among the groups.

(Table. 5) Significant differences were observed in NPC and vergence facility across groups (p < 0.001).

NPC was more receded in myopic isometropia (10 ± 1 cm), whereas both simple and compound anisometropia showed closer NPC values (4 ± 0 cm and 4 ± 1 cm).

Vergence facility was highest in myopic isometropia (13.5 ± 1.5 cpm) and significantly reduced in simple (9 ± 2 cpm) and compound anisometropia (9 ± 1 cpm), indicating decreased vergence adaptability in anisometropic individuals.

(Table. 6) Positive fusional vergence (PFV) at both near and distance differed significantly among the groups.

Myopic isometropia demonstrated consistently higher PFV values, indicating robust fusional reserves. Both simple and compound anisometropia showed reduced blur, break, and recovery values, with greater reduction in compound anisometropia.

These findings suggest that increasing refractive asymmetry is associated with diminished fusional vergence capacity.

(Table.7) Stereopsis showed a statistically significant reduction (p < 0.001) in compound anisometropia (30 ± 90 seconds of arc), indicating impaired binocular sensory integration.

However, negative fusional vergence (NFV), AC/A ratio, and phoria did not show significant differences (p > 0.05), suggesting that these parameters remain relatively stable despite anisometropic changes.

Table 1. Baseline Characteristics and Overall Comparison of Key Binocular Vision Parameters among the Three Groups

Parameter	Myopic Isometropia (n = 25) Median ± IQR (Range)	Simple Myopic Anisometropia (n = 25) Median ± IQR (Range)	Compound Myopic Anisometropia (n = 25) Median ± IQR (Range)	P-value
NPA (OU)	9 ± 1.5 (6 – 11)	4 ± 1 (3 – 9)	4 ± 1 (3 – 4)	**< 0.001***
NRA (D)	1.75 ± 0.25 (1 – 2.5)	1 ± 0.5 (0.5 – 2.5)	0.75 ± 0.25 (0.5 – 1.25)	**< 0.001***
PRA (D)	3 ± 0 (2.75 – 3)	3 ± 0 (2.5 – 3)	3 ± 0.25 (2.5 – 3)	0.064
AF (OU) (cpm)	10.5 ± 2 (8 – 14)	11.5 ± 1.5 (8.5 – 14)	9.5 ± 11 (0 – 12)	**< 0.001***
MEM (D)	0.5 ± 0.25 (0.25 – 0.5)	0.25 ± 0.25 (0 – 0.5)	0.25 ± 0.5 (0 – 0.5)	**0.025***
NPC (cm)	10 ± 1 (7 – 12)	4 ± 0 (3 – 10)	4 ± 1 (2 – 10)	**< 0.001***
PFV Near – Break (Δ)	14 ± 2 (10 – 16)	10 ± 2 (8 – 14)	12 ± 2 (8 – 14)	**< 0.001***
Vergence Facility (cpm)	13.5 ± 1.5 (10 – 16)	9 ± 2 (7 – 14)	9 ± 1 (8 – 10)	**< 0.001***
Stereopsis (sec of arc)	15 ± 0 (15 – 15)	15 ± 15 (15 – 30)	30 ± 90 (15 – 120)	**< 0.001***
AC/A Ratio	3 ± 1 (3 – 4)	4 ± 1 (3 – 4)	3 ± 1 (3 – 4)	0.497
Phoria (Near)	0	0	0	–
Phoria (Distance)	0	0	0	–

*Statistically significant (p < 0.05)

Table 2. Comparison of Amplitude of Accommodation (NPA – OD, OS, OU) Among Groups

Parameter	Myopic Isometropia (n = 25) Median ± IQR (Range)	Simple Myopic Anisometropia (n = 25) Median ± IQR (Range)	Compound Myopic Anisometropia (n = 25) Median ± IQR (Range)	P-value
NPA (OD)	11 ± 1.5 (9.5 – 13)	10 ± 7 (3 – 13)	4 ± 1 (3 – 4)	**< 0.001***
NPA (OS)	11 ± 0.5 (9 – 12)	11 ± 8 (3 – 13)	4 ± 1 (3 – 4)	**< 0.001***
NPA (OU)	9 ± 1.5 (6 – 11)	4 ± 1 (3 – 9)	4 ± 1 (3 – 4)	**< 0.001***

*Statistically significant ($p < 0.05$)

Table 3. Comparison of Relative Accommodation (NRA and PRA) Among Groups

Parameter	Myopic Isometropia (n = 25) Median ± IQR (Range)	Simple Myopic Anisometropia (n = 25) Median ± IQR (Range)	Compound Myopic Anisometropia (n = 25) Median ± IQR (Range)	P-value
NRA (D)	1.75 ± 0.25 (1.00 – 2.50)	1.00 ± 0.50 (0.50 – 2.50)	0.75 ± 0.25 (0.50 – 1.25)	**< 0.001***
PRA (D)	3.00 ± 0.00 (2.75 – 3.00)	3.00 ± 0.00 (2.50 – 3.00)	3.00 ± 0.25 (2.50 – 3.00)	0.064

*Statistically significant ($p < 0.05$)

Table 4. Comparison of Accommodative Facility (OD, OS, OU) and MEM among Groups

Parameter	Myopic Isometropia (n = 25) Median ± IQR (Range)	Simple Myopic Anisometropia (n = 25) Median ± IQR (Range)	Compound Myopic Anisometropia (n = 25) Median ± IQR (Range)	P-value
AF (OD) (cpm)	13 ± 1.5 (11 – 15)	12 ± 2 (10 – 14)	9.5 ± 12 (0 – 14)	**< 0.001***
AF (OS) (cpm)	12.5 ± 1.5 (10 – 14)	12 ± 1.5 (10 – 14)	9 ± 13 (0 – 14)	**0.002***
AF (OU) (cpm)	10.5 ± 2 (8 – 14)	11.5 ± 1.5 (8.5 – 14)	9.5 ± 11 (0 – 12)	**< 0.001***
MEM (D)	0.5 ± 0.25 (0.25 – 0.5)	0.25 ± 0.25 (0 – 0.5)	0.25 ± 0.5 (0 – 0.5)	**0.025***

*Statistically significant ($p < 0.05$)

Table 5. Comparison of Near Point of Convergence (NPC) and Vergence Facility among Groups

Parameter	Myopic Isometropia (n = 25) Median ± IQR (Range)	Simple Myopic Anisometropia (n = 25) Median ± IQR (Range)	Compound Myopic Anisometropia (n = 25) Median ± IQR (Range)	P-value
NPC (cm)	10 ± 1 (7 – 12)	4 ± 0 (3 – 10)	4 ± 1 (2 – 10)	**< 0.001***
Vergence Facility (cpm)	13.5 ± 1.5 (10 – 16)	9 ± 2 (7 – 14)	9 ± 1 (8 – 10)	**< 0.001***

*Statistically significant ($p < 0.05$)

Table 6. Comparison of Positive Fusional Vergence (PFV) at Near and Distance among Groups

Parameter	Myopic Isometropia (n = 25) Median ± IQR (Range)	Simple Myopic Anisometropia (n = 25) Median ± IQR (Range)	Compound Myopic Anisometropia (n = 25) Median ± IQR (Range)	P-value
PFV Near – Blur (Δ)	10 ± 4 (6 – 14)	8 ± 4 (4 – 12)	8 ± 2 (0 – 10)	**0.001***
PFV Near – Break (Δ)	14 ± 2 (10 – 16)	10 ± 2 (8 – 14)	12 ± 2 (8 – 14)	**< 0.001***
PFV Near – Recovery (Δ)	10 ± 4 (8 – 14)	8 ± 4 (4 – 12)	8 ± 2 (6 – 12)	**< 0.001***
PFV Distance – Blur (Δ)	10 ± 2 (6 – 14)	8 ± 4 (4 – 12)	8 ± 2 (2 – 12)	**< 0.001***
PFV Distance – Break (Δ)	14 ± 4 (10 – 18)	12 ± 4 (8 – 16)	12 ± 2 (6 – 16)	**< 0.001***
PFV Distance – Recovery (Δ)	12 ± 2 (8 – 16)	10 ± 4 (6 – 14)	10 ± 2 (4 – 14)	**0.002***

*Statistically significant (p < 0.05)

Table 7. Comparison of Stereopsis and Non-Significant Parameters Among Groups

Parameter	Myopic Isometropia (n = 25) Median ± IQR (Range)	Simple Myopic Anisometropia (n = 25) Median ± IQR (Range)	Compound Myopic Anisometropia (n = 25) Median ± IQR (Range)	P-value
Stereopsis (sec of arc)	15 ± 0 (15 – 15)	15 ± 15 (15 – 30)	30 ± 90 (15 – 120)	**< 0.001***
NFV Near – Break (Δ)	16 ± 4 (10 – 20)	16 ± 4 (10 – 20)	14 ± 4 (10 – 18)	0.276
NFV Distance – Break (Δ)	8 ± 1 (6 – 12)	8 ± 4 (4 – 12)	8 ± 2 (4 – 10)	0.815
AC/A Ratio	3 ± 1 (3 – 4)	4 ± 1 (3 – 4)	3 ± 1 (3 – 4)	0.497
Phoria (Near)	0	0	0	–
Phoria (Distance)	0	0	0	–

*Statistically significant (p < 0.05)

DISCUSSION

In this population-based cross-sectional comparative study, anisometropia was identified as an important factor influencing several components of binocular vision. These findings may be related to differences in retinal image size between eyes with unequal refractive errors. Significant alterations were observed in multiple binocular parameters; however, anisometropia did not show a statistically significant effect on the AC/A ratio, positive relative accommodation (PRA), negative fusional vergence at distance and near, or phoria. Although stereopsis showed clinical deterioration with increasing anisometropia, the difference was not statistically significant.

Among the study groups, compound myopic anisometropia demonstrated the greatest degree of binocular dysfunction, indicating that both the magnitude and type of refractive asymmetry play a crucial role in determining visual performance.

The present findings showed a significant reduction in accommodative amplitude, as evidenced by decreased near point of accommodation (NPA), particularly in anisometropic individuals. These results are consistent with previous studies that report reduced accommodative efficiency in the presence of unequal refractive errors. Chu-chu Zhuang *et al.*[1] observed reduced amplitude of accommodation in individuals with high anisometropia, supporting the findings of the present study. The unequal accommodative demand between the two eyes, especially in myopic anisometropia, may lead to increased visual strain and reduced accommodative performance.[3]

Negative relative accommodation (NRA) was significantly reduced across anisometropic groups, indicating impaired ability to relax accommodation, whereas positive relative accommodation (PRA) did not show significant variation. This suggests that accommodative stimulation mechanisms may remain relatively preserved despite reduced accommodative flexibility. Similar findings have been reported in earlier studies, where PRA remained unaffected in anisometropic individuals despite other accommodative deficits.[1]

Vergence parameters, including positive fusional vergence (PFV) and vergence facility, were significantly reduced in anisometropia. These findings indicate diminished fusional reserves and reduced vergence adaptability. Sustained binocular disparity in anisometropia may disrupt normal vergence development and coordination. Previous studies have also demonstrated that binocular vision disorders become more prevalent with increasing refractive asymmetry and age.[3]

Interestingly, near point of convergence (NPC) was found to be closer in anisometropic groups compared to isometropia. This finding may reflect a compensatory mechanism rather than improved vergence function. Despite this, the significantly reduced vergence facility in anisometropia suggests impaired dynamic vergence control, reinforcing the presence of binocular dysfunction.

Stereopsis, an important measure of binocular sensory function, showed clinical deterioration with increasing anisometropia, with the poorest values observed in compound myopic anisometropia. Although the difference was not statistically significant in all comparisons, the trend aligns with previous studies demonstrating reduced depth perception with increasing interocular refractive differences.[7]

Levi *et al.*[10] reported that myopic anisometropia tends to have relatively better stereopsis compared to hypermetropic anisometropia; however, increasing anisometropic magnitude is consistently associated with poorer stereoscopic outcomes.

Certain parameters, including AC/A ratio, negative fusional vergence (NFV), PRA, and phoria, did not show statistically significant differences among the groups. This suggests that baseline ocular alignment and accommodative convergence relationships remain relatively stable despite the presence of anisometropia. Similar observations have been reported in earlier studies where these parameters were less affected compared to other binocular vision functions.[3]

Although anisometropia has been associated with the development of strabismus and amblyopia, no strabismic cases were identified in the present study. This may be due to the limited sample size or early detection and correction in the study population. Jayashree South *et al.*[11] reported a higher prevalence of amblyopia among anisometropic individuals, highlighting the importance of early diagnosis and intervention.

Overall, the findings of this study emphasize that anisometropia, particularly compound forms, has a substantial impact on binocular visual performance. Early identification and appropriate correction are essential to prevent long-term complications such as suppression, amblyopia, and persistent binocular vision anomalies. Routine binocular vision assessment should therefore be incorporated into the clinical evaluation of individuals with anisometropia to ensure timely management and improved visual outcomes.

CONCLUSION

This study provides valuable insights into the relationship between myopic anisometropia and binocular vision. The findings indicate that myopic anisometropia significantly affects binocular vision components, with reduced binocular integration observed in both simple and compound anisometropia compared to myopic isometropia. These alterations may impact daily visual tasks and overall visual performance. Early detection and appropriate management, including optical correction and vision therapy, may help improve binocular vision outcomes in affected individuals.

REFERENCES

1. Zhuang CC, Zhang L, Pan SS, Wang YN, Guo JX. Accommodation and Binocular Vision in Children with Myopic Anisometropia. J Ophthalmol. 2024 Jan 16;2024: 6525136.
2. Levartovsky S, Oliver M, Gottesman N, Shimshoni M. Long-term effect of hypermetropic anisometropia on the visual acuity of treated amblyopic eyes. Br J Ophthalmol. 1998 Jan; 82(1):55-8.
3. Vincent SJ, Collins MJ, Read SA, Carney LG. Myopic anisometropia: ocular characteristics and aetiological considerations. Clin Exp Optom. 2014 Jul.
4. Cheng CY, Yen MY, Lin HY, Hsia WW, Hsu WM. Association of ocular dominance and anisometropic myopia. Invest Ophthalmol Vis Sci. 2004 Aug.
5. Weakley DR Jr, Birch E, Kip K. The role of anisometropia in the development of accommodative esotropia. J AAPOS. 2001 Jun;5(3):153-7.
6. Linke SJ, Richard G, Katz T. Prevalence and Associations of Anisometropia with Spherical Ametropia, Cylindrical Power, Age, and Sex in Refractive Surgery Candidates. Investigative Ophthalmology & Visual Science. 2011 Sep;52(10):7538-47.
7. Lee JY, Seo JY, Baek SU. The effects of glasses for anisometropia on stereopsis. American journal of ophthalmology. 2013 Dec;156(6):1261-6.
8. Logan NS, Radhakrishnan H, Cruickshank FE, Allen PM, Bandela PK, Davies LN, Hasebe S, Khanal S, Schmid KL, Vera-Diaz FA, Wolffsohn JS. IMI Accommodation and Binocular Vision in Myopia Development and Progression. Investigative Ophthalmology and Visual Science. 2021 Apr 28; 62(5).
9. Liu L. Clinical study on binocular motion parameters of children and adolescents with myopia anisometropia. International Eye Science. 2018 Dec 3;18(12):2285-8.
10. Levi DM, McKee SP, Movshon JA. Visual deficits in anisometropia. Vision Research. 2011; 51(1):48-57. Doi: 10.1016/j.visres.2010.09.029.
11. South J, Gao T, Collins A, Lee A, Turuwhenua J, Black J. Clinical Aniseikonia in Anisometropia and Amblyopia. British and Irish Orthoptic Journal. 2020; 16(1):44-54.