IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Association Between Headache and Non-Strabismic Binocular Vision Anomalies: A Cross-Sectional Study

[1]Yukta Bakshi, [2]Aleena Saifi, [3]Renu Thakur

[1]Demonstrator, [2]Academic Head, [3]Professor

[1]Department of Optometry,

[1]Maharishi Markandeshwar Deemed to Be University, Mullana, India

Abstract:

Objectives: To evaluate the incidence of non-strabismic binocular vision abnormalities (NSBVA) in patients reporting headache at a tertiary level eye care hospital in North India.

Methods: A cross-sectional observational research was carried out on 120 patients (37.5% males, 62.5% females; aged 7-39 years) visiting PC Sharma Eye Hospital, Ambala, Haryana during the period of September 2025 to January 2026. All patients who complain of asthenopia, headache, eye strain and/or excessive near-work/screen time after first eye examination were chosen for thorough orthoptic assessment to detect NSBVA.

Results: In 40% of the 120 subjects, binocular vision was normal. The most frequent defect was convergence insufficiency (CI), which was seen in 30.83% of individuals. Accommodative insufficiency (AI) was seen in 9.17%, accommodative excess (AE) in 8.33%, divergence excess (DE) in 2.5% and convergence excess (CE) in 1.67% of instances. The mean value of near point of convergence (NPC) was 9.02 ± 3.46 cm and the mean accommodative facility (AF) was 9.93 ± 2.91 cycles per minute.

Conclusion: NSBVA are widespread among individuals between 7 and 39 years who come to tertiary eye care centres. Convergence insufficiency is the most common malfunction. Routine eye examination should include detailed evaluation of binocular vision especially in symptomatic persons so as to facilitate prompt diagnosis and therapy.

Index terms: Non strabismic; binocular vision; convergence insufficiency; headache; accommodative dysfunction; vergence; orthoptic evaluation

I. INTRODUCTION

Binocular vision is the cooperative function of both eyes in producing a single, clear, three-dimensional percept of the visual world. This high level of visual capacity relies upon the accurate integration of ocular alignment, sensory fusion, vergence, and accommodation.[1] Normal binocular vision is required for everyday visual activities such as reading, writing, and continuous close-up work on digital displays. This loss of coordination is often linked to visual discomfort, asthenopia and reduced visual efficiency in the absence of any obvious ocular deviation. Non-strabismic binocular vision abnormalities (NSBVA) are a heterogenous set of functional diseases in which the ocular alignment is grossly normal but there is a failure of the binocular visual system to work efficiently.[2] These anomalies include accommodative insufficiency (AI), accommodative excess (AE), accommodative infacility, convergence insufficiency (CI), convergence excess (CE), divergence excess (DE), and divergence insufficiency. Because there is no obvious ocular deviation, NSBVA are often missed during normal ophthalmological exams unless a specific binocular vision test battery is performed.

Patients with NSBVA usually appear with a combination of symptoms including asthenopia, headache, intermittent diplopia, blurred vision at near distance, photophobia, and visual fatigue.[3] The symptoms typically develop with extended near work or screen time. Undiagnosed NSBVA in children and adolescents may impact reading fluency, academic understanding and general school performance and may result in misdiagnosis of learning or behavioural problems. In adults, these abnormalities impair job productivity and influence quality of life negatively.[4]The exponential increase in digital gadget use has placed increased pressures on the accommodation and vergence systems, which may precipitate or exacerbate latent binocular vision abnormalities.[5] NSBVA are significantly underdiagnosed despite their significant functional effects, in part because to symptom overlap with refractive errors, dry eye illness and ocular surface diseases and in part due to lack of standardised binocular vision screening in many clinical settings.[6]Epidemiological statistics on prevalence of NSBVA vary widely between published research, reflecting changes in participant age, diagnostic criteria, test batteries employed, and study methodology.[7,8] Particularly few are reliable estimates of prevalence from tertiary eye care facilities in India. Such data are crucial for assessing clinical load, devising targeted screening techniques and planning appropriate treatment measures including visual therapy and patient education.[9,10] Hence, the current research was conducted to establish the incidence and pattern of NSBVA in patients with headache coming to a tertiary eye care facility in North India to provide data to support thorough binocular vision screening in routine clinical settings.

II. METHODOLOGY

Study setting and design: This cross-sectional observational research was undertaken at PC Sharma Eye Hospital, Ambala, Haryana, India from September 2025 to January 2026.
The research followed the principles of the Declaration of Helsinki. Written informed consent was collected from all study subjects and from the parents or legal guardians of paediatric patients.
Sample method and sample calculation: The participants were selected using convenience sampling method and sample size was calculated using the standard formula for estimating a single population proportion formula:

$$n = Z^2 \times p(1-p) / E^2$$

Where:
n = required sample size
Z = standard normal deviate at 95% confidence interval (1.96)
p = expected prevalence/proportion (27.5% or 0.275) and
E = allowable error or precision (8% or 0.08)
$n = (1.96)^2 \times 0.275\ (1 - 0.275) / (0.08)^2$
$n = 3.84 \times 0.275 \times 0.725 / 0.0064$
$n = 0.7656 / 0.0064$
$n = 119.6$
Therefore, the minimum required sample size was approximately **120** participants.

Participants: A convenience sample of 120 patients aged 7 to 39 years was enrolled. Eligible were males and females reporting at least one of the following symptoms close to near work or screen use: headache, asthenopia, eye strain or trouble in maintaining concentration at near distance. The patients considered had best-corrected visual acuity (BCVA) of 6/9 or better at distance and N6 or better at close in both eyes. Cycloplegic refraction was conducted in all paediatric patients. The exclusion criteria included evident strabismus, previous ocular surgery, systemic or neurological diseases, amblyopia, uncorrected refractive problems and anisometropia more than 2.50 dioptres.

Clinical evaluation: All participants had a thorough binocular vision assessment including: A structured history followed by...
(i) Cover test and prism-bar cover test for ocular deviation at distance (6 m) and near (33 cm); (ii) Royal Air Force (RAF) rule for near point of convergence (NPC) and monocular/binocular near point of accommodation (NPA); (iii) Positive and negative fusional vergences (PFV/NFV) at distance and near with horizontal prism bars; (iv) Monocular Estimate Method (MEM) retinoscopy for accommodation lag or

lead; (v) Vergence facility with a 3Δ base-in/12Δ base-out flipper (cycles per minute, cpm); (vi) Accommodative facility monocular and binocular with ±2.00 DS flippers (age appropriate), expressed in cpm.[11] NSBVA was diagnosed according to criteria previously reported by Lara et al.[12] Patients who did not meet the requirements for any particular defect were categorised as having normal binocular vision.

Statistical analysis: All study data were entered into Microsoft Excel and evaluated using descriptive statistics. Categorical data were analysed using frequency distributions and percentages while continuous variables were presented as means with standard deviations (SD). The threshold of statistical significance was considered as $p < 0.05$.

III. RESULTS

Demographic characteristics: A total of 120 subjects participated in the study, including 75 females (62.5%) and 45 men (37.5%), with female predominance in all the age groupings. The mean age among study participants was 22.59 ± 8.68 years with the age range from 7 to 39 years including children, adolescents and young adults – a group especially vulnerable to NSBVA due to increasing near-work and academic stress as depicted in figure 1.

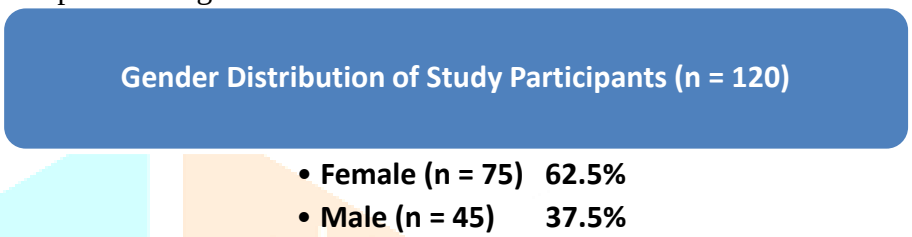

Figure 1. Gender distribution of study participants (n = 120). Female participants constituted 62.5% (n = 75) and male participants 37.5% (n = 45) of the total cohort.

Eye Alignment (Phoria Testing) Assessment of ocular alignment at distant fixation showed that most of the subjects were orthophoric (91.67%) whereas 8.33% had exophoria, no esophoria was found at distance. In contrast, close fixation showed a significantly distinct pattern. Orthophoric patients were 36.67%, exophoric patients were 53.33% and esophoric patients were 10.00% as shown in Table 1. This marked shift towards latent deviation at close fixation highlights the increased sensitivity of the vergence system during persistent near activities.

Table 1. Distribution of phoria at distance and near fixation (n = 120)

Phoria Type	Distance Fixation (%)	Near Fixation (%)
Orthophoria	91.67	36.67
Exophoria	8.33	53.33
Esophoria	0.00	10.00

Binocular vision elements which are presented in Table 2 summarises quantitative examination of binocular vision characteristics. The mean NPA of 7.64 ± 2.33 cm was higher than predicted age-adjusted normative values and had a positively skewed distribution, indicating that a significant number of subjects had decreased accommodative amplitude. The mean NPC of 9.02 ± 3.46 cm (range: 5–16 cm) was over the clinical criterion of < 6 cm, indicating receding convergence in a large percentage of the population.[13] Vergence facility (VF) was 10.36 ± 2.74 cpm which is lower than the normative criteria of ≥ 15 cpm suggesting reduced vergence adaptability. Similarly, accommodative facility (AF) of 9.93 +/− 2.91 cpm was less than the predicted standard of ≥ 11 cpm consistent with accommodative infacility. Together, our data support a significant burden of accommodative and vergence-related dysfunction in this patient population.[14]

Table 2. Summary of binocular vision parameters (n = 120)

Parameter	Mean ± SD	Range	Normative Value
Near Point of Accommodation (NPA,cm)	7.64 ± 2.33	4–14	Age-dependent
Near Point of Convergence (NPC,cm)	9.02 ± 3.46	5–16	≤ 6 cm
Vergence Facility (VF,cpm)	10.36 ± 2.74	4–16	≥ 15 cpm
Accommodative Facility (AF,cpm)	9.93 ± 2.91	3–16	≥ 11 cpm

NPA = Near Point of Accommodation; NPC = Near Point of Convergence; VF = Vergence Facility; AF = Accommodative Facility; SD = Standard Deviation; cpm = cycles per minute.

NSBVA prevalence: Among 120 patients, 40.00% (n = 48) of the patients had normal binocular vision and 60.00% (n = 72) of the patients had one or more NSBVA. The individual prevalence of each ailment is summarised in table 3 and represented in figure 2. The most common reported anomaly was convergence insufficiency (30.83%) followed by accommodative insufficiency (9.17%), accommodative excess (8.33%), divergence excess (2.50%) and convergence excess (1.67%).

Table 3. Prevalence of non-strabismic binocular vision anomalies (n = 120)

Diagnosis	n (patients)	Prevalence (%)
Normal binocular vision	48	40.00
Convergence Insufficiency (CI)	37	30.83
Accommodative Insufficiency (AI)	11	9.17
Accommodative Excess (AE)	10	8.33
Divergence Excess (DE)	3	2.50
Convergence Excess (CE)	2	1.67
Total	120	100.00

CI = Convergence Insufficiency; AI = Accommodative Insufficiency; AE = Accommodative Excess; DE = Divergence Excess; CE = Convergence Excess.

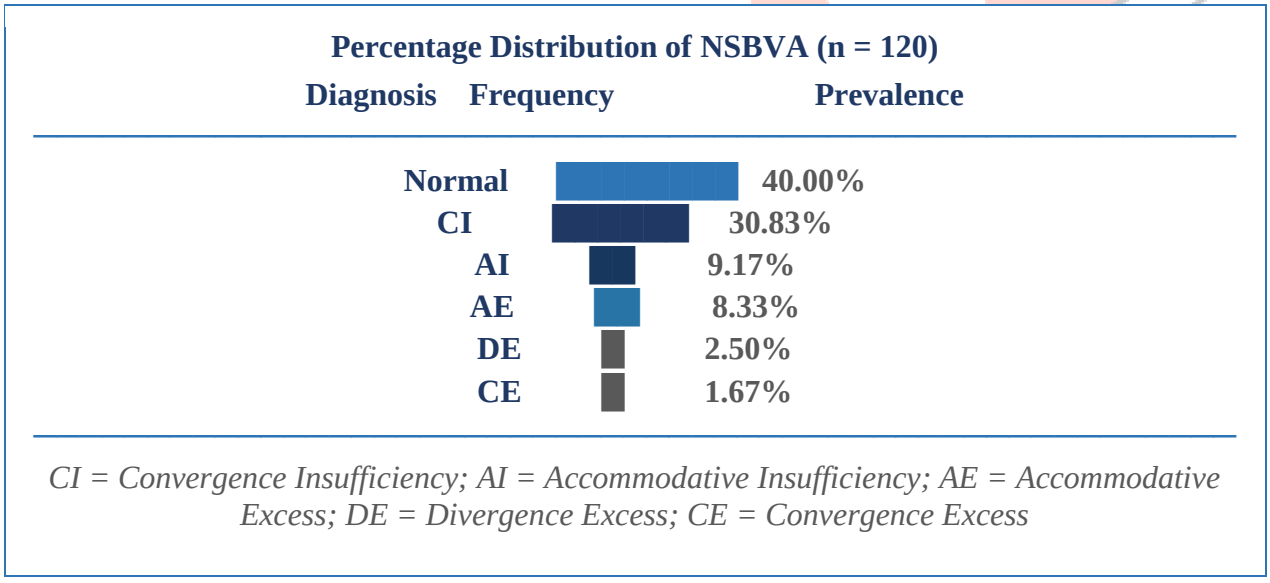

Figure 2. Percentage distribution of NSBVA diagnoses among study participants (n = 120). Convergence insufficiency was the predominant anomaly, identified in 30.83% of patients.

IV. DISCUSSION

The current research reports a high frequency of non-syndromic binocular vision anomalies (NSBVA) in patients with headache presenting to a tertiary eye care centre in North India. Sixty % of the individuals had diagnostic criteria for at least one binocular vision problem. These results are consistent with emerging evidence that NSBVA is an important but under-recognized category of visual impairment, especially in populations with high near-work and screen-time demands.

The female predominance (62.5%) in this research is in correlation with the age-stratified results of Rao, where females were in majority in the 10– 20 and 31–40 year age categories.[15] This tendency may be due to different help-seeking behaviour, a higher frequency of near work related symptoms among female

students and professionals, or hormonal effects on accommodation and vergence.[16] However, due to the absence of research particularly examining gender distribution in NSBVA populations, definite findings are not possible.

The most common NSBVA in the present sample was convergence insufficiency (30.83%), which is consistent with the general consensus from clinical and population-based research in different geographic locations.6,7,8 In a cohort with a total NSBVA incidence of 62.2%, CI was the most frequent anomaly among North Indian university students (37.2%) as reported by Shongmu and Akhtar, followed by accommodative insufficiency (12.2%) and accommodative infacility (7.2%).[17] The considerably lower overall frequency in our research (60%) could reflect variations in diagnostic criterion thresholds, the clinical vs student-based sample frame, or the inclusion of a larger age range.

The observation that 53.33% of subjects had close exophoria compared to only 8.33% at distance is physiologically compatible with convergence insufficiency and highlights the near-distance mismatch typical of this illness. An increase in NPC (mean 9.02 ± 3.46 cm) and decrease in vergence facility (10.36 ± 2.74 cpm) support the clinical diagnosis of functional vergence weakness at near while an increase in NPA (7.64 ± 2.33 cm) and decrease in accommodative facility (9.93 ± 2.91 cpm) give objective evidence of concurrent accommodative dysfunction.13,14

Underdiagnosis of NSBVA in ordinary ophthalmology practice is still a significant clinical issue. Symptoms overlap with uncorrected refractive error, dry eye and tension-type headache sometimes mask patient symptoms of binocular aetiology.[18] Without a systematic orthoptic examination, such as measurements of NPC, fusional vergences, and accommodative capability, these diseases are likely to be misdiagnosed and intervention may be unsuitable or delayed. The high frequency of CI and accommodating dysfunction shown in this research indicates that binocular vision testing should be systematically included in ophthalmology outpatient clinics, especially for symptomatic patients engaged in demanding close work.

Management evidence supports office-based vergence or accomodative therapy and home-based convergence exercises for CI. Accommodative and vergence disorders may be treated using prism correction, appropriate optical intervention and structured vision therapy programmes.[19,20] Educating patients on visual hygiene, such as the 20-20-20 rule (20 seconds of fixation at 20 feet after every 20 minutes of close work), is a useful adjunct to minimise digital eye strain and increase symptom awareness.[21]

This research has certain drawbacks. Limitations include the convenience sampling approach and single-centre design. The lack of a control group does not allow a direct comparison of the prevalence of headache in NSBVA-positive and NSBVA-negative individuals. In addition, the length of the usage of digital devices was not systematically measured in the research and might be an important confounding variable. Future prospective, multi-center research with standardised methodologies and sufficient controls are needed.

V. CONCLUSION

The current investigation confirms NSBVA to be common in individuals aged 7–39 years presenting with headache to a tertiary eye care institution in North India. 60% of participants fulfilled diagnostic criteria of at least one abnormality. The most prevalent diagnosis was convergence insufficiency (30.83%), followed by accommodative insufficiency and accommodative excess. The results demonstrate a significant diagnostic lacuna and re-affirm the need of a detailed binocular vision examination as an important part of normal ophthalmic practice. Early detection and proper care of NSBVA with vision therapy, prism correction, and patient education may greatly reduce visual discomfort, improve educational and vocational performance, and improve quality of life.

Limitations: The research is hampered by single-center convenience sampling, limited sample size, the lack of a comparison group, cross-sectional study design, and inability to identify digital screen time as a confounding variable.

Future scope: Future research should target large scale multi-centre prospective studies with control groups, longitudinal follow up, comprehensive measurement of screen time and randomised trials testing vision treatment approaches across varied populations.

VI. FUNDING: Nil

VII. CONFLICT OF INTEREST: None

VIII. REFERENCES:

1. Blake R, Wilson H. Binocular vision. Vision Research. 2011;51(7):754–70.
2. Evans BJW. Pickwell's Binocular Vision Anomalies. 6th ed. Oxford: Elsevier Health Sciences; 2021.
3. García-Muñoz Á, Carbonell-Bonete S, Cacho-Martínez P. Symptomatology associated with accommodative and binocular vision anomalies. J Optom. 2014;7(4):178–92.
4. Majumder C, Toh CL. Non-strabismic binocular vision anomalies among students of a Malaysian private university using visual display units. Int Eye Sci. 2020;20(6):940–5.
5. Sigamani S, Majumder C, Sukumaran S. Changes in accommodation with visual fatigue among digital device users. Med Hypothesis Discov Innov Optom. 2022;3(2):63–9.
6. Yushan D, Hong Z. Frequency and associated factors of accommodative and non-strabismic binocular vision dysfunctions among clinical adults in Western China: a cross-sectional study. Medicine. 2025;104(34):e43881.
7. Lai CY, Luo CK, Zhao W, et al. Prevalence of non-strabismic binocular vision anomalies and age-related changes among middle-aged and older adults: a systematic review. BMC Ophthalmol. 2025;25(1):452.
8. Alhassan M, Alhijji H, Alruways K, et al. Prevalence of refractive errors and non-strabismic binocular vision anomalies in symptomatic and asymptomatic university students in Saudi Arabia. Saudi J Ophthalmol. 2025;[Epub ahead of print]. doi:10.4103/sjopt.sjopt_2025.
9. Sengupta R. Insight into the impact of vision therapy on academic performance of children with learning disabilities and binocular vision anomalies: a comprehensive review. IJRAR. 2023;10:43–54.
10. Bhowmick A, Kumar PP, Ratra D. Frequency of non-strabismic binocular vision anomalies among optometrists in a tertiary eye care centre in Southern India. Indian J Occup Environ Med. 2024;28(2):138–42.
11. Russell GE, Wick B. A prospective study of treatment of accommodative insufficiency. Optom Vis Sci. 1993;70(2):131–5.
12. Lara F, Cacho P, García A, Megías R. General binocular disorders: prevalence in a clinic population. Ophthalmic Physiol Opt. 2001;21(1):70–4.
13. Alhassan M, et al. [Duplicate of reference 8 — see above].
14. Malhotra V. A questionnaire-based study to assess the correlation between visual symptoms and NSBVA among Tibetan college students of Bangalore [Doctoral dissertation]. Arka Jain University; 2023.
15. Rao D. Prevalence of non-strabismic binocular vision disorders in patients with asthenopia. J Multidiscip Res Healthc. 2014;1:33–41.
16. Rani A, Chander A. Prevalence and patterns of non-strabismic binocular vision anomalies in young adults with hypermetropia: a clinical cross-sectional study. Adv Res Teach. 2025;26(3):1–8.
17. Shongmu TL, Akhtar Z. Prevalence of non-strabismic binocular vision anomalies (NSBVA) among university students of North India. Indian J Clin Exp Ophthalmol. 2024;10(2):281–7.
18. Hashemi H, Saatchi M, Yekta A, et al. High prevalence of asthenopia among a population of university students. J Ophthalmic Vis Res. 2019;14(4):474–82. doi:10.18502/jovr.v14i4.5455.
19. Hussaindeen JR, Shah P, Ramani KK, Ramanujan L. Efficacy of vision therapy in children with learning disability and associated binocular vision anomalies. J Optom. 2018;11(1):40–8.
20. Hassan LI, Ibrahim SM, Abdu M. Efficacy of home-based vision therapy for convergence insufficiency in secondary school students. Sudanese J Ophthalmol. 2017;9(1):

21. Datta S, Sehgal S, Bhattacharya B, Satgunam PN. The 20-20-20 rule: practicing pattern and associations with asthenopic symptoms. Indian J Ophthalmol. 2023;71(5):2071–5.