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Indian Journal of Clinical and Experimental Ophthalmology

Journal homepage: www.ijceo.org

Original Research Article

# Clinical profile and associations of binocular vision dysfunction at a vision therapy clinic of a tertiary eye institute in India

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ARTICLE INFO

*Article history:*
Received 29-09-2023
Accepted 22-12-2023
Available online 04-07-2024

*Keywords:*
Binocular vision dysfunction
Convergence insufficiency
Accommodative insufficiency
Tertiary eye clinic
Convergence excess
Accommodative infacility
Vision therapy
Asthenopia

ABSTRACT

**Aim:** Review the incidence of binocular dysfunctions, clinical features, their association with binocular vision disorders and refractive status at a vision therapy clinic of a tertiary eye institute in India.

**Materials and Methods:** In this retrospective study, the clinical record of all the patients of binocular dysfunction was obtain from Electronic medical record (EMR). We reviewed the record of 527 symptomatic patients with binocular vision dysfunction related problems who were referred between July 2022 to June 2023, to binocular vision therapy clinic. Out of which 393 patients (74.57%) who had accommodative dysfunction were included in the study. Patients with any ocular surgery, manifest strabismus, amblyopia, anisometropia (more than 2.00 dioptres), ocular pathology, neurological disorders, were not included in the review. Prepresbyopic patient also excluded from this study. All clinical assessments were done by one of the two experienced optometrists.

**Result:** Of the 527 symptomatic patients examined, 74% (393 subjects) showed binocular dysfunction. Among the 393 binocular dysfunction patients, most of them diagnose with convergence insufficiency (18.82%), convergence insufficiency with accommodative insufficiency (26.97%), convergence insufficiency with accommodative infacility (23.40%), convergence insufficiency with accommodative excess (19.24%), poor PFV (4.58%), and convergence excess (6.36%).

**Conclusion**: In conclusion, we have evaluated the binocular vision dysfunctions of a non-presbyobic population. Out of 527 symptomatic patients examined, 74% (393 patients) showed had binocular dysfunctions. Incident CI was more than CE. This study will provide the prevalence data of binocular vision dysfunction. The study will also provide insight into the differences in binocular vision parameters. A diagnosis of binocular dysfunction depends not only on a few clinical findings of some accommodative and binocular investigations but on a whole battery of tests, in order to produce diagnosis of the type of dysfunction of the patient. For this reason optometrists should systematically complement their routine examination with a whole battery of accommodative and binocular tests that would help to avoid the non-detection of these anomalies in daily optometric practice.



## 1. Introduction

In addition to refractive anomalies like nearsightedness, farsightedness and astigmatism, accommodative and binocular vision problems are also among the most

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https://doi.org/10.18231/j.ijceo.2024.054

common visual disorders encountered in vision therapy clinics. These conditions can affect a person's ability to focus their eyes, work together effectively and maintain clear and comfortable vision.[1] These dysfunctions present a variety of associated symptoms, including blurred vision, difficulty in focusing at different distances, headache and ocular pain.[2] Efficient accommodative and vergence systems are essential for the comfortable reading and performing near tasks as they enable the ability to perform these activities with ease.[3] Binocular vision dysfunction and accommodative dysfunction can diminish the clarity and binocular perception of visual information, leading to reduced comfort and efficiency during close-up tasks like reading, writing, and computer-based work. Binocular vision dysfunction refers to the eyes inability to properly align and stabilize a clear image on the retina.[4]

Accommodation and convergence are closely coupled physiological processes in the visual system. This coupling helps to maintain a clear and single binocular vision when looking at objects at various distances.[5,6] Based on research conducted by Borsting et al., it was found that a significant percentage of children diagnosed with convergence insufficiency, approximately 77.9%, also exhibited Accommodative Insufficiency (AI) either as the main cause or as a coexisting factor. Similarly, among elementary school children, 4.7% had accommodative insufficiency as the primary cause, while 3.3% had it as a coexisting factor, which contributed to heightened symptoms.[7]

In most of the studies it is reported that higher incidence of convergence excess than convergence insufficiency.[8,9] Hence, our objective was to examine the occurrence of binocular vision issues, and to assess their characteristics, and to explore their connections with accommodative problems at a vision therapy clinic located within a tertiary eye hospital in central India.

## 2. Materials and Methods

This retrospective study aimed to investigate binocular vision dysfunction in patients referred to a binocular vision therapy clinic between July 2019 and July 2020. Here are some key points from the study:

1. Study population: The study included 527 symptomatic patients with binocular vision dysfunction-related problems. However, only 393 of these patients (approx. 74%) were included in the study.
2. Exclusion criteria: The study excluded patients who had undergone ocular surgery, had manifest strabismus (misalignment of the eyes), had amblyopia (lazy eye), had anisometropia exceeding 2.00 dioptres (a significant difference in refractive power between the two eyes), had ocular pathology (eye diseases), or had neurological disorders. Pre-presbyopic patients (those who had not yet developed presbyopia, an age related vision change) were excluded.
3. Data source: The clinical records of those patients were obtained from the Electronic Medical Record (EMR) system, indicating that the data used for the study were collected from patient's medical records.
4. Assessment team: All clinical assessments were performed by one of two experienced optometrists, suggesting that there was consistency in the evaluation process.

Below are the case history and clinical assessments:

1. Case history include
   (a) Patient's personal information (name, age, gender).
   (b) Chief complaint or reason for seeking binocular vision therapy.
   (c) Relevant medical history (e.g., eye surgeries, trauma, systemic illness).
   (d) Family history of eye-related conditions.
   (e) Medications and allergies.
2. Visual acuity:
   (a) Best corrected visual acuity for distance measured using a log MAR chart.
   (b) Near visual acuity measured in N notation and converted to log MAR.
   (c) Ocular examination include
   (d) Versions and duction: Evaluate the patient's eye movements and assess for any limitations or abnormalities.
   (e) Papillary status: Check for papillary reactions to light and accommodation.
3. Sensory examination:
   (a) Stereo-acuity: was measured using Titmus Stereo Fly Test.
   (b) Assessed binocular vision and fusion at both distance and nearby worth four-dot test.
4. Fusional amplitude: Binocular alignment (horizontal fusional amplitude) was performed using horizontal prism bar.
5. AC/A ratio were calculated by using Gradient Method.
6. Near point of convergence (NPC) was measured by using RAF (Royal Air Force) rule to determine the closest point at which the patient can keep their eyes converged.
7. Accommodative function:
   (a) Monocular and binocular accommodative facility was measured by using +- 2 lenses flipper.
   (b) Accommodative response was measured by using Monocular Estimated Method (MEM).

(c) NRA (Negative relative accommodation) and PRA (Positive relative accommodation) were performed to assess the relative accommodation ability using loose lenses from trial set.

In this study, binocular dysfunctions were characterized, and the results of each assessment in the records were measured against the standard values and diagnostic criteria by Scheiman and Wick.

## 3. Result

**Table 1:** Frequency and percentge gender distribution of participants

| Demographic Data Parameters | | Frequency | Percentage (n=100) |
|---|---|---|---|
| Gender | Female | 226 | 57% |
| | Male | 169 | 43% |

Table 1 shows out of 393 participants in vision therapy clinic, 226 (57%) were female and 169 (43%) were Male.

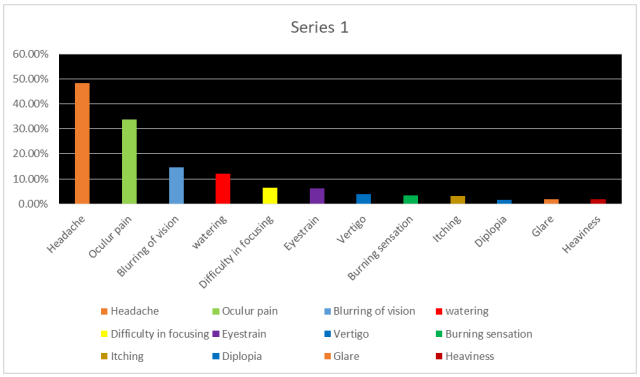


**Figure 1:** Bar diagram shows that symptom among the participants

According to BFigure 1, Out of 393 (74%) individuals presented with symptoms (Table 2) in this study. The principal symptom among the subjects was asthenopia, including the most majorities are complained of headache (48.30%), and then complained of ocular pain (33.80%). In addition (14.50%) of the subjects reported Blurring of Vision, (11.95%) Watering, (6.40%) difficulty in focusing, (6.11%) eye strain, (3.82%) vertigo, (3.30%) burning sensation, (3.10%) itching, (1.52%) diplopia, (1.80%) Glare, (1.78%) heaviness.

In convergence insufficiency, convergence insufficiency with accommodative insufficiency, convergence insufficiency with accommodative infacilty, convergence insufficiency with accommodative excess, convergence excess headaches, ocular pain and asthenopia were the most frequently reported symptoms. However, in the group poor fusional vergence eyestrain, difficulty in focusing, heaviness were the most frequently symptoms. Intensive near work, digital devices have brought many binocular dysfunction.

**Table 2:** Frequency and percentage distribution of binocular dysfunction

| Parameters | Frequency | % |
|---|---|---|
| Headache | 190 | 48.30% |
| Ocular pain | 133 | 33.80% |
| Blurring of vision | 57 | 14.50% |
| Watering | 47 | 11.95% |
| Difficulty in focusing | 25 | 6.40% |
| Eyestrain | 24 | 6.11% |
| Vertigo | 15 | 3.82% |
| Burning sensation | 30 | 3.30% |
| Itching | 12 | 3.10% |
| Diplopia | 6 | 1.52% |
| Glare | 7 | 1.80% |
| Heaviness | 7 | 1.78% |

Among 393 patients examination we got 18.82% had Convergence Insufficiency (CI), 26.97% had convergence Insufficiency associated with Accommodative Insufficiency (CI with AI), 23.40% Convergence Insufficiency associated with accommodative infacility, 19.24% convergence insufficiency with Accommodative Excess (CI with AE), 4.58% Poor Fusional Vergence (PFV), 6.36% convergence excess.

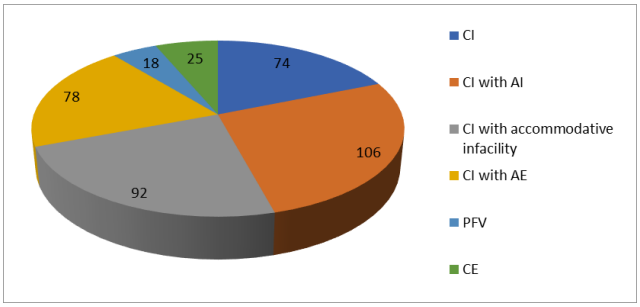


**Figure 2:** Distribution of binocular dysfunction

## 4. Discussion

In contemporary society, the rise in computer usage and close-range activities over the last few decades has exacerbated issues related to binocular dysfunctions. Convergence Insufficiency (CI) stands out as the most prevalent and manageable type of binocular dysfunction. Individuals afflicted with CI experience visual fatigue as a result of their binocular vision system breaking down, resulting in eye strain during tasks that require close-up focus.

Among 393 subjects that were enrolled and examined in this study, 74 subjects (18.82%) was convergence insufficiency which is more prevalent than Convergence

Excess 25 subjects (6.36%). 106 subjects (26.97%) was convergence Insufficiency with accommodative Insufficiency and it is more prevalent than convergence insufficiency with accommodative excess (19.24%) and convergence insufficiency with accommodative infacility (23.40%). It was observed that our results were different from the other studies so no one study is relatable for convergence Insufficiency with accommodative insufficiency.

Convergence insufficiency (CI) refers to the difficulty in effectively bringing the eyes together and sustaining that convergence during close-up tasks. This condition can result in eye strain and discomfort when working on tasks at a close distance. The symptoms can include a range of issues such as eye redness, discomfort in and around the eyes, hazy vision, frontal headache and occasional double vision when focusing on nearby objects. It's important to note that CI is a recognized and manageable condition. In 2019, a similar research investigation was conducted by Ramesh Shruthy Vaishali et al.[10] Their study aimed to determine the prevalence of Convergence Insufficiency (CI) and its potential connection with body mass index (BMI) in individuals aged 18-35 years. Among the 142 participants, consisting of 61 males and females, they observed that 27.5% of the population exhibited CI. Additionally, they found that fusional vergence dysfunction was present in 12.7% of the participants. In our study, the prevalence of CI is slightly higher at 18.82%, and fusional vergence dysfunction is lower at 4.58%.

Drawing direct comparisons between our findings and those of other researcher is challenging due to variations in study populations and diagnostic criteria employed by each study. In a study conducted by Francisco Lara and colleagues in 1999,[8] the primary objective was to determine the occurrence of non-strabismic accommodative and binocular dysfunctions within a clinical population. They described convergence insufficiency (CI) as the near point of convergence being less than 10 cm, having more Exophoria for near vision than for distance vision and displaying positive fusional vergence of less than 18 prism dioptre. The prevalence of CI was quantified as a percentage of the population, they found 4.5% of convergence excess (CE) which was more prevalent than CI, in our study CE is 7.12%.

Unlike Lara's research, our study reveals variations in the prevalence of dysfunctions. These disparities could stem from the diverse diagnostic criteria employed across studies or possibly from variations in the criteria used for assessment. Some authors diagnosed convergence insufficiency (CI) solely based on low NPC values with an accommodative target, while others utilized various orthoptic parameters associated with convergence in order to determine their final diagnosis.

Similarly, Scheiman et al.[9] (1996) studied a clinical paediatric population of 2023 patients and their results showed that the most common disorders recorded (after refractive ones) were binocular (14.3%) and accommodative (5.4%). Convergence excess (7.1%) was more prevalent than convergence insufficiency (4.6%).

Magdalene.[11] Analysed a sample of 131 subjects aged from 10-40 years attending the vision therapy clinic. Among 131 individual, 81 (61.83%) were female and 50 (38.17%) were male. The percentage of female was higher than that of male which is similar to present study. In our study out of 393 subjects, 226 were female and 169 were male. The age group included 6-35 years. The percentage of females (57%) was higher than that of the males (43%). In a related research conducted by Rao,[12] it was found that there was higher proportion of males compared to females. Among the 182 patients in the study, 118 were males, while 64 were females. It's worth noting that there have been limited studies that have investigated the distribution of sexes in individuals with binocular dysfunction.

The predominant binocular issue identified in all age group was convergence insufficiency (CI), with accommodative insufficiency (AI) and convergence excess (CE) following. In Magdalene's research,[11] it was determined that the prevalence of CI was 37.10% in the 10-20 years age range, 38.77% in the 21-30 years age group, and 20% in the 31-40 years age group. Consequently, CI emerged as the prevailing binocular dysfunction.

In study by Daum,[13] a retrospective review of patients diagnosed with symptomatic CI, patients reported the symptoms in frequency: blur (47%), headaches (54%), asthenopia (36%), and diplopia (47%). In our study also the most complained symptoms are headache (48.30%). Daum found that among 179 patients reported greater prevalence of 61.4% had convergence insufficiency and 10% had divergence excess. Likewise, in another investigation conducted by Esteben et al,[14] involving 65 students who did not exhibit apparent refractive issues, amblyopia, or strabismus, a noticeable binocular disorder was detected in 32.3% of the participants. This included 7.7% with convergence insufficiency and 3.1% with basic Exophoria. In our study, we also observed a higher prevalence of convergence insufficiency.

Jameel Rizwana Hussaindeen,[15] conducted a research project in Tamil Nadu, India, with the aim of determining the occurrence of non-strabismic anomalies in binocular vision. The study revealed that the prevalence of these anomalies in Urban and rural areas stood at 31.5% and 29.6%, respectively. Among the various non-strabismic anomalies, convergence insufficiency was the most commonly observed, with a prevalence of 16.5% in urban areas and 17.6% in rural areas. The research found no significant variations in the occurrence of non-strabismic anomalies between urban and rural settings (according to

a Z-test, p>0.05). Furthermore, the prevalence of non-strabismic anomalies in binocular vision was notably higher in the 13 to 17 years age group (36.2%) compared to the 7 to 12 years age group (25.1%).

In a study conducted in South Korea, the analysis among the 589 participants, a study found that 28.55% of primary school children displayed various forms of non-strabisic accommodative or vergence dysfunction.[16] Specially, 13.2% exhibited issues related to accommodation, while 9% had problems with vergence. Notably, among these dysfunctions, convergence insufficiency (10.3%) was more widespread than convergence excess (1.9%), and accommodative insufficiency (5.3%) was more common than accommodative excess (1.2%).

Most of the previous studies showed that accommodative dysfunctions were more prevalent than vergence dysfunctions, excluding the study of Lara et at,[8] Scheiman,[17] examined a group of 2023 pediatric patients in a clinical setting and found that, the most frequently observed disorders were binocular problems at 14.3% and accommodative issues at 5.4%. Additionally, there was a higher prevalence of convergence excess at 7.1% compared to convergence insufficiency at 4.6%. It can be observed that the prevalence of convergence insufficiency is not particularly large. The population examined in that study was younger than ours, the results obtained were different to those reflected in our study with similar diagnostic criteria. It seems that the variances in our findings compared to those of other researchers, which indicate a higher prevalence of convergence excess over convergence insufficiency in a pre-presbyopia population, stem from the specific criteria employed to diagnose each condition. When a limited number of tests are utilized to identify these disorders, the outcome may lead to an inaccurate diagnosis.

In conclusion, this and similar studies highlight the evident occurrence of binocular dysfunctions within the general clinical population. A comprehensive evaluation of binocular abilities, alongside refractive assessments, is essential to prevent the oversight of these disorders during routine eye examinations.

## 5. Conclusion

In this study we have evaluated the binocular vision dysfunctions of a non-presbyobic population. Among the 527 symptomatic patients that were, 74% (equivalent to 393 individuals) exhibited binocular dysfunctions. Notably, the occurrence of convergence insufficiency exceeded that convergence excess. This study offers valuable prevalence statistics concerning binocular vision dysfunction and sheds light on variations in binocular vision parameters. Diagnosing binocular dysfunction relies on a comprehensive set of tests, encompassing both accommodative and binocular assessments, rather than just a few clinical findings. Therefore, it's crucial for optometrists to consistently incorporate a wide range of accommodative and binocular tests into their standard examinations. This approach is essential to prevent the oversight of such anomalies in their everyday optometric practice and to accurately identify the specific dysfunction in each and every patient.

## 6. Source of Funding

None.

## 7. Conflict of Interest

None.

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**Cite this article:** Sah SK, Yadav RK, Chauhan H, Kumar P, Ali A, Singh R. Clinical profile and associations of binocular vision dysfunction at a vision therapy clinic of a tertiary eye institute in India. *Indian J Clin Exp Ophthalmol* 2024;10(2):302-307.