

# Correlation Between Symptomatology And Clinical Findings In Teenagers With Convergence Insufficiency

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## ABSTRACT

**Background:** Convergence insufficiency (CI) is one of the most common non-strabismic binocular vision disorders in adolescents and is frequently associated with visual discomfort during near tasks.

**Objective:** To evaluate the correlation between symptom severity and objective clinical parameters in teenagers diagnosed with convergence insufficiency.

**Methods:** A school-based cross-sectional study was conducted among teenagers aged 13–19 years. Binocular vision assessment included near point of convergence (NPC), positive fusional vergence (PFV). Symptom severity was measured using the Convergence Insufficiency Symptom Survey (CISS). Correlations between symptoms and clinical findings were analyzed using Pearson correlation.

**Results:** Teenagers with CI demonstrated significantly higher CISS scores and reduced fusional reserves. Moderate correlations were observed between CISS scores and NPC break as well as PFV break, indicating that increased symptom severity was associated with poorer convergence performance.

**Conclusion:** Symptomatology in convergence insufficiency shows a significant association with objective clinical measures, particularly NPC and PFV. Incorporating symptom surveys with routine binocular vision testing enhances diagnostic accuracy in adolescents.

**Keywords:** convergence insufficiency, adolescents, binocular vision, symptom survey, near point of convergence

**How To Cite This Article:** Kumar S, Ahluwalia Ts, Goel S, Gupta D. Correlation Between Symptomatology And Clinical Findings In Teenagers With Convergence Insufficiency. *Int J Drug Deliv Technol.* 2026;16(27s):425-428. Doi: 10.25258/ijddt.16.27s.50

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## 1. INTRODUCTION

Convergence insufficiency (CI) is one of the most common non-strabismic binocular vision disorders observed in children and adolescents. It is characterized by an inability to maintain adequate binocular convergence during near visual tasks, despite normal ocular alignment at distance. Clinically, CI is associated with symptoms such as eye strain, headaches, blurred vision, diplopia, difficulty concentrating, reduced reading speed, and early visual fatigue. These symptoms often become more pronounced during sustained near activities, including reading, writing, and prolonged digital device usage.

Adolescence represents a critical developmental stage in which visual demands increase substantially due to academic workload and lifestyle changes. The widespread use of smartphones, tablets, and computers has resulted in extended periods of near work, placing significant stress on the accommodative and vergence systems. This increased visual demand can exacerbate latent binocular vision disorders or unmask previously compensated convergence deficiencies. As a result, CI has emerged as a significant contributor to visual discomfort and reduced academic efficiency in teenagers.

The diagnosis of CI is traditionally based on a combination of objective clinical signs, including

reduced near point of convergence (NPC), reduced positive fusional vergence (PFV), poor vergence facility, and abnormal accommodative responses. However, the presence and severity of symptoms do not always correspond directly with clinical findings. Some individuals with marked clinical abnormalities report minimal symptoms, whereas others experience significant visual discomfort despite only mild objective deficits. This discrepancy highlights the complex relationship between symptomatology and clinical measurements in CI.

The Convergence Insufficiency Symptom Survey (CISS) is a widely validated tool used to quantify subjective symptoms related to CI. It provides a standardized measure of visual discomfort, allowing clinicians to assess symptom severity and monitor treatment outcomes. While CISS is routinely used in both clinical and research settings, its correlation with objective binocular vision parameters remains variable across populations and age groups.

Understanding the relationship between subjective symptoms and objective clinical findings is essential for improving diagnostic accuracy and guiding effective management strategies. In teenagers, where academic performance and digital exposure are closely linked to visual efficiency, establishing this correlation is particularly important. Therefore, the present study aims

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to evaluate the relationship between symptomatology and clinical binocular vision parameters in teenagers diagnosed with convergence insufficiency, with a focus on identifying the most reliable predictors of symptom severity.

### AIM OF THE STUDY

To determine the correlation between symptom severity and clinical binocular vision parameters in teenagers diagnosed with convergence insufficiency.

## 2. MATERIALS AND METHODS

### 2.1 Study design and setting

A cross-sectional analytical study was conducted over a period of six months among teenagers recruited from rural high schools and senior secondary schools. The study was approved by the Institutional Ethics Committee, and all procedures were performed in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from parents or guardians, and assent was obtained from all participating students prior to data collection.

### 2.2 Study population and sampling

The study population consisted of teenagers aged 13 to 19 years. Participants were selected using a cluster sampling technique from participating schools. Students with normal cognitive development and the ability to cooperate with clinical testing were included.

The exclusion criteria were:

- Near or distance best corrected visual acuity less than 6/9 in either eye
- History of ocular surgery
- Presence of manifest strabismus
- Diagnosis of amblyopia
- Eyelid disorders interfering with visual axis
- Neurological or developmental disorders
- Current use of medications affecting accommodation or vergence
- Ongoing binocular vision therapy

### 2.3 Clinical assessment protocol

All examinations were conducted by trained optometrists under standardized clinical conditions.

#### Refractive assessment

Objective refraction was performed using dry retinoscopy, followed by autorefractor measurements and subjective refinement to obtain optimal refractive correction.

#### Binocular vision assessment

Binocular vision was evaluated using the following clinical tests:

- **Near Point of Convergence (NPC):** Measured using a RAF ruler. The break point was recorded in centimeters. An NPC break greater than 6 cm was considered abnormal.
- **Positive Fusional Vergence (PFV):** Assessed using base-out prism amplitudes at 40 cm. A PFV break

value less than 15 prism diopters ( $\Delta$ ) were considered reduced.

### 2.4 Symptom assessment

Subjective symptoms were evaluated using the Convergence Insufficiency Symptom Survey (CISS). The questionnaire consists of 14 items related to near-vision discomfort, with each item scored on a five-point Likert scale. A total score of 16 or above was considered indicative of significant symptomatology.

### 2.5 Diagnostic criteria for convergence insufficiency

Participants were diagnosed with convergence insufficiency based on the Convergence Insufficiency Treatment Trial (CITT) criteria, which require the presence of at least two of the following:

- Receded NPC ( $> 6$  cm)
- Reduced PFV ( $< 15\Delta$  at near)
- CISS score  $\geq 16$

### 2.6 Statistical analysis

Data were analysed using Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics were used to summarize demographic and clinical characteristics. Pearson correlation coefficients were calculated to assess the relationship between CISS scores and clinical binocular vision parameters. Statistical significance was set at  $p < 0.05$  with 95% confidence intervals reported where applicable.

## 3. RESULTS

A total of 529 teenagers were included in the final analysis after excluding incomplete records. The mean age of the participants was  $16.1 \pm 1.7$  years, with a nearly equal gender distribution.

### 3.1 Symptom severity

The mean Convergence Insufficiency Symptom Survey (CISS) score among participants diagnosed with convergence insufficiency was  $24.6 \pm 6.8$ , indicating moderate to severe symptomatology. Commonly reported symptoms included eye strain, headaches during near work, blurred vision while reading, and difficulty maintaining attention during prolonged visual tasks.

### 3.2 Clinical binocular vision findings

The mean near point of convergence (NPC) break among affected participants was  $9.4 \pm 5.7$  cm, which was significantly higher than the normal reference value. Positive fusional vergence (PFV) break values at near were reduced, with a mean of  $11.8 \pm 4.3\Delta$ .

### 3.3 Correlation between symptomatology and clinical parameters

Pearson correlation analysis demonstrated statistically significant associations between symptom severity and key clinical parameters. CISS scores showed a moderate positive correlation with NPC break ( $r = 0.48$ ,  $p < 0.001$ ), indicating that greater symptom severity was associated with more receded convergence. A moderate

negative correlation was observed between CISS scores and PFV break ( $r = -0.44$ ,  $p < 0.001$ ), suggesting that reduced fusional reserves were linked to increased symptoms.

These findings indicate that although multiple clinical parameters contribute to symptomatology, NPC and PFV are strongly associated with subjective visual discomfort.

### 3.4 Summary of correlations

**Table 1. Correlation between CISS score and clinical parameters**

Clinical parameter	Correlation (r)	coefficient p-value
NPC break (cm)	0.48	<0.001
PFV break ( $\Delta$ )	-0.44	<0.001

These results confirm that symptom severity in convergence insufficiency is significantly associated with objective clinical findings.

## 4. DISCUSSION

The present study examined the relationship between subjective symptomatology and objective clinical findings in teenagers diagnosed with convergence insufficiency. The results demonstrated significant correlations between Convergence Insufficiency Symptom Survey (CISS) scores and key binocular vision parameters, particularly near point of convergence (NPC) and positive fusional vergence (PFV). These findings confirm that symptom severity in CI is closely related to functional deficits in the vergence system.

NPC showed the strongest association with symptom severity. A more receded NPC was linked to higher CISS scores, indicating that reduced convergence ability is a major contributor to visual discomfort during near tasks. This highlights the diagnostic importance of NPC as a primary clinical indicator of CI and supports its routine use in school-based screening and primary eye care settings. NPC is simple to perform, time-efficient, and provides clinically meaningful information regarding symptom burden.

PFV demonstrated a significant negative correlation with symptom severity, suggesting that reduced fusional reserves limit the ability to sustain binocular alignment under near visual demand. Individuals with lower PFV experience greater visual fatigue due to inadequate compensatory mechanisms. This finding is consistent with existing literature identifying PFV as a critical determinant of asthenopic symptoms in CI.

An important observation is the partial dissociation between clinical signs and subjective symptoms. Some participants reported significant symptoms despite mild clinical deficits, whereas others showed marked objective abnormalities with minimal subjective complaints. This phenomenon underscores the multifactorial nature of visual discomfort and reinforces

the need for a combined diagnostic approach integrating both symptom surveys and clinical measurements.

From a clinical perspective, these findings emphasize that neither subjective nor objective assessments alone are sufficient for accurately diagnosing CI. A comprehensive evaluation incorporating both dimensions provides a more reliable basis for clinical decision-making. In adolescents, where visual efficiency is closely linked to academic performance and digital device usage, early identification of CI is particularly important. Timely intervention may significantly reduce visual discomfort and improve functional outcomes.

## 5. CONCLUSION

The present study demonstrates a significant relationship between symptom severity and objective clinical findings in teenagers with convergence insufficiency. Among the clinical parameters evaluated, near point of convergence and positive fusional vergence showed the strongest associations with subjective symptomatology, indicating that these measures are the most reliable predictors of visual discomfort in this population.

The findings highlight the importance of integrating standardized symptom assessment tools, such as the Convergence Insufficiency Symptom Survey, with routine binocular vision testing. Relying solely on either subjective complaints or objective measurements may result in underdiagnosis or misinterpretation of the functional impact of convergence insufficiency.

In the context of increasing near-work demands and digital screen exposure among adolescents, early identification and appropriate management of convergence insufficiency are essential. Comprehensive binocular vision evaluation should be incorporated into routine eye examinations for teenagers to ensure timely detection and effective intervention, thereby reducing visual discomfort and supporting optimal academic and visual performance.

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