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Prevalence and Impact of Convergence Insufficiency among school going children of North 24 Parganas District in West Bengal

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Abstract

Background: Increasing concern of parents for poor academic performance of their child is a rising concern in school going population in North 24 Parganas district of West Bengal. Convergence Insufficiency (CI) being the most common form of Non- strabismic Binocular Vision Disorder (NSBVA) prevailing in this group can be attributed for the above concern.
Aim: To estimate the prevalence of convergence insufficiency in school going children and also its impact on academic performances.
Methods: The study included 485 participants: 215 males and 270 females in an age group ranging 6-15 years. Data was collected from school screening camps after detailed history taking and ophthalmic examination. Associated academic performance and involvement in extracurricular activities were also recorded. The diagnosis of CI was based on three criteria – exophoria for near, receded NPC and poor Positive Fusional Vergence (PFV) range. Descriptive analysis was applied on the collected data using statistical software.
Results: The average values were calculated as per the age groups. The prevalence of CI in the population pool was 4.90%. Prevalence was more in females about 56% when compared to male 44%. Average break point of NPC was recorded to be 5.42 cm, and average recovery of NPC was 7.44 cm. Average PFV break noted was 27Δ and PFV recovery noted was 13Δ.
Conclusion: The struggle to grasp complex subjects can thus be attributed to this cause and need for motivating children for extracurricular activities including physical fitness. This study concludes that in this electronic era, NSBV workup among this group should be emphasized.

1.INTRODUCTION

Aside from refractive errors, accommodative and binocular vision problems are among the most commonly encountered visual disorders in children. These conditions are collectively known as non-strabismic binocular vision anomalies (NSBVA). [1-3] Among the various types of NSBVA, the prevalence of CI in school-age children is about 2% and 10%, depending on diagnostic criteria and population. [3,5,8] Using standardized criteria based on exophoria greater at near, receded near point of convergence (NPC), and reduced positive fusional vergence (PFV), CI prevalence has been estimated at around 5% in Spanish school children and 6-7% in Portuguese cohorts. [1,3]

Convergence Insufficiency (CI) is a binocular vision disorder, where the patient has problem in sustaining convergence during near work.[4] This leads to difficulty in concentrating, while reading and writing, eyestrain, blurred or double vision, headache. [3,15] In recent days there is a noticeable increase in this problem particularly in children, largely because of growing use of digital device use at near. [15,19] Early detection and appropriate management of these conditions can greatly improve a child's visual comfort and overall quality of life. [4-6]

Children with CI report higher levels of visual and performance-related symptoms, including reduced reading speed, loss of place, reduced concentration, reduced memorizing ability, compared to individuals with normal binocular vision.[7,14] Parents and teachers of CI patients often report difficulty in completing school work, avoiding reading, attention-related difficulties and greater concern about school performance.[11,14] Studies have shown that CI, weak PFV and exophoria at near are significantly more common in children with poor academic performance, emphasizing the fact that binocular vision problems can negatively influence classroom achievement.[14,17]

Evidence on causality is mixed. While CI clearly affects comfort and behaviour during near tasks, a meta-analysis of CI treatment trials found little to no true effect of CI therapy on objective reading performance beyond placebo effects, indicating that CI is likely one

of several contributing factors to academic difficulties rather than a sole cause. Nevertheless, improvements in academic performance have been documented after successful CI treatment, such as increased interest in reading and fewer adverse school behaviour. [6,14]

Most published data come from North America, Europe, Africa, and parts of Asia, and prevalence varies with urbanisation, diagnostic criteria and educational demand. [8,9] Urban and high demand academic environments may be associated with higher rates of vergence anomalies due to intensive near work and increasing use of e- devices. However, region-specific data from many parts of India are limited, and there is a need to document CI prevalence and its impact in local school populations. Given these limitations, there is a clear need for region-specific studies to better understand the burden of these conditions. The present study aims to assess the prevalence of convergence insufficiency among school-going children in North 24 Parganas, where such data are currently lacking. Understanding the prevalence of CI and its relationship with academic performance among school-going children in North-24 parganas can provide essential baseline data in planning targeted screening, referral, and intervention strategies in this region. [14,15,16]

2. METHODOLOGY

Study Design and Sample size

A cross-sectional descriptive study was conducted in selected schools of Barasat, West Bengal, India, from January 2025 to May 2025 among school-going children of age 5 to 15years with the aim to determine the prevalence of convergence insufficiency and its association with academic performance and binocular vision parameters. The sample size was calculated using the standard formula for prevalence studies: n = $Z^2 \times p \times q / d^2$

Assuming an expected prevalence of 10 %, a 95% confidence level, and 3% precision, which yielded a minimum sample size of approximately 384; however, a total of 485 participants were included after seeing the inclusion criteria.

The inclusion and exclusion criteria for the study were as follows:

Inclusion Criteria:

- School children of class I to IX having ages 5 to 15 years were included
- Best Corrected VA 6/9 or better in each eye at distance and N6 at near
- Minimal refractive error up to ± 5.00DS & up to ± 1.50DC.

Exclusion Criteria

- Any kind of intermittent/ constant strabismus or ocular misalignment.
- Anisometropia > 1.50 D between two eyes.
- Manifest or latent nystagmus
- Accommodative anomalies
- Systemic Illness

Participants were screened through organized school screening camps after obtaining necessary permissions from school authorities and informed consent from parents or guardians. Assent from the students were taken before their participation.

Data Collection Procedure

Each participant underwent a comprehensive evaluation that included both clinical assessment and academic performance data collection. The procedure was carried out in a structured manner in sequence as follows- history taking focused on asthenopic symptoms, visual acuity assessment, refraction, cover test, Near point of Accommodation (NPA), Near point of convergence (NPC), Positive fusional Vergence (PFV) both for near and distance. The ocular misalignment was evaluated using prism bar cover test at distance (6 m) and near (40 cm) to assess heterophoria, particularly near exophoria. Binocular vision assessment included measurement of NPC using pencil push-up test, blur and recovery point were noted. PFV for distance and near was measured using horizontal prism bars, with blur, break and recovery values recorded in prism dioptres.

Convergence insufficiency was diagnosed based on standard clinical criteria including near exophoria greater than distance by ≥ 4 prism dioptres, receded NPC (>6 cm), and PFV <15Δ blur or failure to meet Sheard's criterion was considered reduced. Academic performance was categorised in to good (≥75%), average (50-74%) and poor (<50%) based on most recent annual examination grade cards.

Statistical Analysis

The primary variables analysed in this study included: a) Near exophoria, b) Near Point of Convergence (NPC), c) Positive Fusional Vergence (PFV) at distance and near. These variables were evaluated for their association with academic performance and age. The data collected in this study were carefully entered, coded in MS- Excel. Descriptive analysis and further association and comparison across the academic performance group was done using IBM SPSS version 26.0 (IBM Corp., Armonk, New York, USA).

3. RESULT

Among the 485 school- going children, the prevalence of convergence insufficiency was found to be 4.95%. The statistics in Table:1 shows a higher prevalence among males (5.93%) compared to females (3.72%). Also, there was statistically no significant association between gender and convergence insufficiency (x^2 = 1.237, p = 0.266). Table: 2 shows the comparison of NPC and PFV parameters across academic performance groups. The mean NPC (break) was obtained at 5.43 ± 1.35 cm across all age groups. The Kruskal-Wallis test showed a statistically significant difference across academic performance groups (H = 26.688, p < 0.001), with the children having poor academic performance showing more receded NPC values. Similarly, PFV parameters at near- blur, break and recovery showed significant differences across academic performance group (p < 0.001), with reduced PFV value seen in children with poorer academic outcomes. For distance, PFV range for blur and recovery were significantly associated with academic performance (p < 0.001), while PFV break did not show statistical significance (p=0.053). Age-wise analysis revealed a significant difference in NPC break (p=0.004), indicating more receded NPC in older children, and a significant variation in distance PFV break (p=0.028), whereas other vergence parameters did not show significant differences across age groups.

Table: 1 **Association between Gender and Convergence Insufficiency**

Gender	Convergence Insufficiency		Total N	Chi-square value (df=1)	p- value
	Present n (%)	Absent n (%)			
Males	16 (5.93)	254 (94.07)	270	1.237	0.266
Females	8 (3.72)	207 (96.28)	215		
Total N	24	461	485		

Table: 2 Comparison of NPC and PFV Parameters across Academic Performance Groups

Parameters	Academic Performance	N	Mean Rank	H-Value (df=2)	p- value
NPC-Break (cm)	Good	156	220.52	26.688	<0.001*
	Average	200	227.50		
	Poor	129	294.22		
PFV(Near) Blur	Good	156	267.15	29.967	<0.001*
	Average	200	254.02		
	Poor	129	196.70		
PFV(Near) Break	Good	156	254.73	48.620	<0.001*
	Average	200	258.86		
	Poor	129	204.22		
PFV(Near) Recovery	Good	156	254.99	47.496	<0.001*
	Average	200	262.79		
	Poor	129	197.82		
PFV(Distance) Blur	Good	156	266.56	21.763	<0.001*
	Average	200	251.85		
	Poor	129	200.78		
PFV(Distance) Break	Good	156	248.25	5.870	0.053
	Average	200	251.90		
	Poor	129	222.85		
PFV(Distance) Recovery	Good	156	244.13	41.988	<0.001*
	Average	200	277.07		
	Poor	129	188.82		

Kruskal-Wallis test was used for comparison. A p-value <0.05 was considered statistically significant.

4. DISCUSSION

The present study demonstrated a significant association between academic performance and binocular vision parameters, where students with good and average academic performance demonstrated higher mean ranks, while those with poor academic performance consistently showed lower values. This indicates that children who struggle academically may also have a reduced ability to recover binocular fusion, highlighting the functional importance of vergence mechanisms in learning. [15,17]

Students with poor academic performance showed significantly reduced Positive Fusional Vergence (PFV) values at near (blur, break, and recovery), suggesting compromised binocular vision function. Since tasks such as reading and writing rely heavily on sustained near vision, reduced fusional reserves can directly affect a child's ability to perform efficiently in academic settings. [13,15,17]

Overall, the findings of this study demonstrate a clear relationship between binocular vision function, academic performance, and age among school children.

Children with poor academic performance consistently showed a receded Near Point of Convergence (NPC) along with reduced PFV at near. In contrast, students with good and average performance exhibited better convergence ability and stronger fusional reserves. The statistically significant association between NPC and academic performance suggests that inefficient binocular vision, particularly reduced convergence, may negatively impact reading ability, attention, and overall learning efficiency. [14,17]

Although a slightly higher prevalence of convergence insufficiency (CI) was observed in males, the difference was not statistically significant. This aligns with previous studies, indicating that gender does not play a major role in the occurrence of CI. [5,9]

Binocular vision parameters showed noticeable variation with age. NPC values tended to become more receded as age increased, suggesting a gradual reduction in convergence ability in older children. Distance PFV also showed a mild decline with age, while near PFV remained relatively stable with slight reductions. These trends may reflect developmental changes in the visual system and increasing visual demands with age. [13,19]

The prevalence of convergence insufficiency in this study was found to be 4.9%, based on clinical signs such as receded NPC, greater exophoria at near, and reduced PFV. This is lower than some previously reported prevalence rates (13%–17.6%), but is comparable to findings from certain school-based studies that reported rates as low as 2% in specific age groups. [5,8]

One possible explanation for the lower prevalence observed in this study could be the active involvement of students in extracurricular activities. A considerable proportion of children participated in sports and outdoor activities, which may help reduce prolonged near visual stress and support better binocular coordination. [15]

Additionally, most students in this cohort demonstrated average to good academic performance, which may indicate a lower overall burden of severe binocular vision dysfunction. The urban setting of the study may also have contributed to better awareness, improved access to eye care services, and earlier detection of visual problems. [11,12]

It is important to acknowledge that there is limited region-specific data on convergence insufficiency in this area, making direct comparisons with other populations difficult. Therefore, this study provides useful baseline information for the local population. However, differences in diagnostic criteria, study design, and sample characteristics across studies should be considered when interpreting prevalence rates. [8]

Despite these findings, certain limitations must be considered. The cross-sectional design does not allow for establishing cause-and-effect relationships, and the study was limited to selected schools in an urban area. Therefore, the results may not be fully generalizable to rural populations or other regions.

5. CONCLUSION

The findings of this study indicate that convergence insufficiency (CI) is an important non-strabismic binocular vision disorder among school-aged children, with noticeable effects on both learning ability and involvement in extracurricular activities. Even though the prevalence recorded in this study is lower than some earlier reports, it remains consistent with globally documented ranges, confirming that CI continues to be relevant within the Indian paediatric population. Although causality cannot be established due to cross-sectional design, these findings suggest that reduced binocular visual efficiency may be associated with difficulties in sustained near tasks such as reading and writing. This highlights the need to incorporate comprehensive binocular vision assessment into school screening programs for early detection and appropriate management of CI, which may improve visual comfort and support better academic performance.

Limitations

This study has several limitations that should be considered while interpreting the findings. The cross- sectional design limits the ability to establish a causal relationship between CI and academic performance. Additionally, the absence of a standardized symptom assessment tool may limit the evaluation of subjective visual complains. Post-hoc analysis was not performed to determine the specific group differences. Future studies with longitudinal designs, and including a broader population are recommended.

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Statement of Disclosure

None of the authors reports any potential conflict of interest.

Financial Interest

No financial support or funding has been received.

Data Availability Statement

The data that support the findings of this study are available on reasonable request from the corresponding author.

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