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Screening of Convergence Disorders and Accommodation Disorders among School Children in Gorakhpur

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ABSTRACT

Accommodative insufficiency (AI) and convergence insufficiency (CI) play a major role in a reading insufficiency.CI is a binocular vision problem but it is not a strabismus. It is generally associated with symptoms such as eyestrain, blurry vision, double vision, headache and reading related problems. AI is a condition that affects the ability to maintain near vision focus for a prolonged time. The purpose of this study was to estimate the frequency of NBV (normal binocular vision), convergence insufficiency and accommodative insufficiency in children 4^{th} to 9^{th} school years in Gorakhpur U.P (India).A comprehensive eye examination and binocular vision assessment, integrating accommodative and convergence parameters, were used to analyse the visual condition. Of the 415 students who completed the eye examination and binocular vision testing. All students in the group of schools of the rural were invited to attend. 415 children were assessed from a total of 450 students (response rate of 92%). fifteen were excluded because they did not meet the inclusion criteria. The assessment was completed by 400 children, 175 females and 225 males. We found significant differences in expected values from the current clinical criteria for near point of convergence (NPC) with penlight, distance and near horizontal phorias, accommodative amplitudes, monocular and binocular accommodative facility (normal distribution $p < 0.001$). The study will also provide insight into the differences in binocular vision parameters between ethnicities, and the minimum battery of tests needed to detect binocular vision anomalies in a community setting.

Key Words: Convergence insufficiency (CI), Accommodative insufficiency (AI) and NBV (Normal binocular vision)

INTRODUCTION

Convergence insufficiency (CI) is a sensory and neuromuscular anomaly of the binocular system, characterized by an inability to accurately converge, or sustain accurate convergence when focusing on near objects. CI is binocular vision problem, but it is not strabismus. It is generally associated with symptoms such as eyestrain, blurry vision, double vision, headaches and reading related problems. Also, to classify children as normal or abnormal as indicated by various authors (Scheiman et al., 2014). It is necessary to know the normal mean values for a battery of different tests conducted as part of BV assessment. In India, the diagnosis of BV anomalies is currently based on the Caucasian normative values from (Morgan et al., (1944) and Duane et al., 1926) as compiled by (Scheiman et al.,2014).Ethnicity based differences in BV parameters have been reported in the literature (Chen et al., 2010). Thus, it becomes more appropriate to have ethnicity-based data in the clinical decision-making process. Hence, we aimed to study the prevalence of BV anomalies among school children in Uttar Pradesh, India, along with the estimation of normative data for BV parameters in this population. Estimates of BV anomalies among school children will help in planning appropriate intervention so that efficient BV and efficient reading can be achieved, thus improving the Vision related quality of life (VR-QOL) of children. The obtained normative data could also benefit the clinical practice and management of BV anomalies.

Different targets for NPC testing have been reported in the literature. In our study, considering the age range to be tested, NPC was assessed using two methods 1) pencil push- up test and 2) using a penlight with red filter in front of right eye.).The NPA is the most important parameter used in the diagnosis of accommodative anomalies. With respect to the measurement's techniques, push-up technique has been considered as a standard one due to its robustness, where the near target equal to or one line better than the best corrected near visual acuity is moved closer to the eyes until a sustained blur is noted. Because of the simplicity of administration and its use in the clinical set-up, the push-up technique was adopted for the study. Refractive and accommodative vergence mechanisms are part of the visual efficiency system, and refractive errors (REs) play a dynamic role in the aetiology and treatment of binocular vision anomalies, including CI by Rouse et al.. AI has been reported to be common cause of asthenopia and other symptoms, in school children, associated with near vision. Usually AI was defined by reduced accommodation amplitude, high values on monocular estimation retinoscopy and failing monocular accommodative facility with minus lenses. Concerning the rates of CI in general populations, several studies show different results.

The literature also includes three studies of school children in the United States (California) that used similar methodology and diagnostic criteria. Criteria for high suspect/definite CI were presence of exophoria at near greater than at distance in addition to insufficient positive fusional vergence (PFV) and/or receded NPC. The criterion for AI was 2D

below Hofstetter's minimum age expected accommodative amplitude (AA). Among the various studies published, the data related to the prevalence of this condition range from 1.7 to 33%.As stated by the CITT (Convergence insufficiency Treatment Trial) group, the presence of one, or more than one sign of CI allows classification of the visual condition at different levels from suspected to definite. The aim of this study have been to estimate the frequency of Normal Binocular Vision (NBV), CI and AI children attending 4^{th} and 9^{th} school years, in a city in Gorakhpur UP(India), quantify the level of symptoms with a scientifically validated scale in each case and assess the disorder of the CI, AI and visual symptoms. Previous studies carried out with school samples, the prevalence of CI and AI were 18.1% and 8%(Marran et al.,2006). The prevalence of non-starbismic anomalies of binocular vision in the rural arms was found to be 29.6%, respectively. CI was the most prevalent 17.6%, respectively report 2 of BAND study (Hussnaindeen et al.,2018).

Objectives

To generate awareness among parents, teachers and students about refractive error and binocular vision anomalies related symptoms. To assess binocular vision function.

To identify and refer students with vision problems using selected vision Screening procedure .To calculate vision, NPC, Amplitude of accommodation, phoria and vergence.

METHODOLOGY

Study design

This is cross sectional study conducted in Gorakhpur A.K Ideal School UP, India. This study approved by the institutional ethical board of the Department of Optometry and Vision Science. Qualified examiners performed the eye examination on all participants to analyze the collected data. The study conducted at the Gorakhpur A.K ideal school UP, India in 2019.The Gorakhpur A.K Ideal school children UP, India different subject randomly invited for the study. class 4^{th} to 9^{th} student was involved. The school principle aware of the study purpose, study material and clinical procedure before participate. We gave a written description to school principle to behalf of all students and also collected written consent from them.

Inclusion and Exclusion criteria

Table 1: Inclusion and Exclusion criteria

INCLUSION CRITERIA	EXCLUSION CRITERIA
Subjects in the age between 7 to 18 years BCVA better than or equal to 6/9, N6 Both gender (male & female) are included VA with habitual correction better or equal to 6/9 N6	History of any previous intraocular /squint surgeries Ocular abnormalities Strabismus Anisometropia ≥ 2 D History of ocular trauma and head trauma.

Subject determination

400 subjects were included in the study by simple random sampling. Age of the Subjects was 7 to 18 years school children attending the 4th to 9th school on the UP-east Gorakhpur during the 2019 school year. All students in the targeted grades were eligible to participate. School principle provided written informed consent behalf of all students. The parameters of concern for the repeatability assessment include NPC with accommodative target, near point of accommodation (NPA), and distance and near fusional vergence amplitudes. The rest of the BV tests were carried out by a single examiner at study site. The repeatability cut-off for negative fissional vergence (NFV), positive fissional vergence (PFV), and NPC have been adopted from Hussanindeen et al (2004). The BV assessments were performed on 30 subjects and the Altman–Bland agreements were determined (Altman & Bland et al., 1983). An area with a minimum population of approximately 7000 with a density of 300 per square kilometre and 75% of male population engaged in agricultural activities was termed as rural population based on the Indian census definition (Indian district database, 2000).

Visual acuity and Refraction

Vision screening

1: Visual acuity at distance and near
2: Static ratinoscopy and subjective acceptance
3: Extra ocular motility
4: Fusional test
5: Pupillary assessment and torch -light examination
6: Cover and uncover test

Table 2: Procedure and normal value of the vision screening test:

Test name	procedure	Value
Visual acuity test	1. Pocket vision screener was used for both distance and near. 2. for distance and near chart kept at 40 cm from the subject 3. Unaided, aided and pinhole visual acuity were recorded	• Best corrected visual acuity was 6/9 or better • Unaided visual acuity 6/24 or better
Fusion test	Worth for dot test was used both for near and distance.	• Positive response both near and distance • Able to recognize all four light and colour
Fusional Vergence test	Horizontal prism bar was used for near and distance	• PFV and NFV for near and distance break point. • Normal value was PFV <15 PD(near)

Extra ocular motility test	Broad H test was used.All the nine gazes were tested both monocular and binocular	Normal in all gaze
Pupillary assessment	It was done by a torch light in Dim illuminated environment	To evaluate pupil shape, size and reaction.

Cover and uncover test, Static Retinoscopy and subjective acceptance

Pass criteria of Vision screening

passing criteria for the vision screening protocol were

1. Visual acuity better than or equal to 20/30(6/ 9) at distance and near N6
2. Normal extra ocular motility
3. No constant or intermittent strabismus as detected using the cover test
5. Normal external and internal ocular condition
6. Normal pupillary reaction and pattern.

Subjects who failed the screening criteria were referred for further management; and subjects who passed the above-mentioned criteria were included for the binocular vision and orthoptic assessment.

Binocular vision evaluation

The room where BV assessment was done were standardized for illumination levels (minimum of 480 Lux were ensured) and a minimum length of 6 m were chosen to perform vision tests and BV assessment for distance and near.The outcome parameters in our study included the NPC, phoria measures for distance and near, vergence amplitudes, NPA, accommodative response, accommodative facility.

Phoria measurement

Asked to see an accommodative target and a prism bar or loose prism was placed before eye .Normal magnitude of latent phoria were listed below (according to Morgan 1944 and Scheiman et al..,2014).

Table 3: Normal magnitude of phoria

Phoria	**Distance**	**Near**
Exophoria	1 PD±2	3PD±3
Esophoria	0	<1PD

Tests for vergence

Near Point of Convergence

In our study, considering the age range to be tested, NPC was assessed using two methods

1. Astron International rule consisting of linear accommodative target of 6/9 reduced Snellen letters.

2. Using a penlight with red filter in front of right eye.

NPC with accommodative target was performed by the RAF ruler. Subjective break and recovery of NPC was measured using PLRG method. Red glass was placed before right eye and green glass was placed before left eye. This data has been published in Indian population, so i have

taken from (Husnaindeen et al., 2016) BAND study. Normal value of near point of convergence were listed below (according to Hussaindeen et al.,2016)

Table 4: Normal values of near point of convergence

Test name	**Value (mean ±SD)**	
	Break	**Recovery**
NPC with Accommodative target	3±3	4±4
NPC with penlight	7±5	10±7

Fusional vergence amplitudes

Fusional vergence were assessed using step vergence technique using a prism bar as it gives the advantage of objectively rechecking the end point for vergence based on the deviation of one of the eyes during testing (Scheiman & Wick, 2014). For both near and far, the NFV was measured first followed by PFV to avoid influence of convergence testing on vergence recovery.

This data has been published in Indian population so i have taken from (Husnaindeen et al., 2018) BAND study. Normal value of PFV and NFV were listed below (according to Hussaindeen et al.,2018)

Table 5: Normal value for the NFV and PFV

Test name		**Value(mean±SD)**		
		Blur	**Break**	**Recovery**
NFV	Distance	x	8±2	6±2
	Near	x	15±11	11±4
PFV	Distance	x	17±8	12±7
	Near	x	26±10	21±10

Vergence facility:

Apart from fusional vergence amplitudes, testing for vergence facility improves the sensitivity of diagn0 is of binocular vision anomalies and a 12 base-out/ 3 base-in prisms combination has been found to differentiate the symptomatic from the normal binocular vision group (Gall et al., 1998). Slip of prism combination was flipped from base-in to out and the subject was asked to keep the vertical row of 6/9 letters clear and single. A practice session for 30sec is provided before the test is begun. One round of base-out and base-in was counted as one cycle and the number of cycles per minute (CPM) was noted down.

TESTS FOR ACCOMMODATION

NEAR POINT OF ACCOMMODATION

The NPA is the most important parameter used in the diagnosis of accommodative anomalies. With respect to the measurements techniques push-up technique has been considered as a standard one because the near target equal to or one line better than the best corrected near visual acuity is moved closer to the eyes until a sustained blur is noted. The readings in metrics were converted to dioptres to arrive at the NPA.

The near point card with 6/6 Snellen equivalent word was used as the target and was brought closer to the right eye until the subject reports sustained blur. The Astron International rule centred on the forehead was used to measure the endpoint of blur. The test was repeated binocularly. Readings was noted down in centimetres and then converted to its dioptric equivalent. Normal value of near point accommodation determined by the age as NPA changed with age.

Hofstetter (1950) formula is used to determine the normal value of the test.

18.5 - (0.30^X patient age in years

Accommodative response

Normative value of NRA and PRA (Rutstein and Hussaindeen et al,. 1993,2016)

Value (Mean ± SD)

Negative relative accommodation +2.00D±0.50D and Positive relative accommodation -2.50D±1.OOD

Accommodative facility

Accommodative facility testing is gaining increasing evidence as a representation of dynamics of the accommodative system. Plus, and minus lenses of ±2.00D were interposed in front of the eyes.. Reading material (standard practice is use of a word rock card consisting of letters of Nl0 and N8 font size) .It will measure both monocular and binocular. This data has been published in Indian population so i have taken from (Husnaindeen et al., 2018) BAND study. Normal value of Accommodative facility were listed below (according to Hussaindeen et al.,2018)

Table 6: Normal value of the Accommodative facility

Accommodative facility	**Value(mean±SD)**	
	7-10 (years)	11-17(years)
Monocular	11±4	14±5
Binocular	10±4	14±5

Diagnostic criteria for CI and AI

The normative data (according to Indian population) we used in our study was collected from the BAND study performed by (Dr Jameel Rizwana Hussaindeen et al.,2018) and is showed in the following table.

Table 7: Diagnostic criteria for CI and AI

Conditions	Sign	Value (in PD)
NBV	1. Distance horizontal phoria	0.02±1
	2. Near Horizontal phoria	-0.4±2
	3. Distance vertical phoria	0±0.5
	4. Near vertical phoria	0±0.5
	5.Near NFV break	15±4
	6. Near NFV recovery	11±4
	7.Near PFV break	26±10
	8.Near PFV Recovery	21±10
	9. Distance NFV break	8±2
	10.Distance NFV Recovery	6±2
	11.Distance PFV break	17±8
	12. Distance PFV recovery	12±7
AI	13. Amplitude of Accommodation (RE): AA > (18.5–0,30*Age)-2 (Hofstetter's average age formula) 14. Monocular Accommodative Facility (RE): MAF 11±4 cpm(7-10 Years) 14±5 cpm (11-17 years)	
CI	15. NPC break >6cm (with AT) 16. NPC break >12cm(with PL) 16. Near exophoria 4Δ greater than distancephoria 17. PFV break <15Δ or failing Sheard's criterion	

Once a child was diagnosed with a NSBVA, appropriate vision therapy protocol (Scheiman et al., 2005, 2008; Scheiman & Wick, 2014, Hussnaindeen et al.,2018) was administered at the school. Vision therapy set-up was planned at the school premises itself to improve compliance and to prevent loss of follow-up. A reassessment of BV parameters was carried at the end of 10 sessions of vision therapy.

DATA ANALYSIS

The Statistical Package for Social Sciences (SPSS) Version 16 was used, Data collected from the clinical test were analyzed by using Microsoft Excel (2017) and SPSS software (version 16.0 for Windows, SPSS Inc., Chicago, IL, USA).

All data were segregated in different excel sheets such as clinical data. Normality of data were estimated from A P-value <0.05 was regarded as statistically significant. According to the normality test, all parameter was nonparametric. Descriptive statistic of proportion was

calculated for all the non-strabismic binocular vision anomalies and normal binocular vision and descriptive statistics included means, standard deviations and medians. The Kolmogorov–Smirnov test was used to assess the normality of data. The Kruskal–Wallis equality-of-population rank non-parametric test was used to compare differences in means between groups.. A significance level of < 0.05 was considered significant.

In order to compare our results with other studies, we first categorized students based on whether or not the following clinical signs were present:

RESULTS

Of the 415 students who completed the eye examination and binocular vision testing. All students enrolled in the 4th to 9th year of education in the group of schools of the rural were invited to attend. 415 children were assessed from a total of 450 students (response rate of 92%). fifteen were excluded because they did not meet the inclusion criteria. The assessment was completed by 400 children, 175 females and 225 males; 65 attended the 4th year, 64 attended 5th, 65 attended 6th,67 attended 7th, 69 attended 8thand 70 attended 9th year. The final sample included 400 students (Male 56.25% and Female 43.75%) with average age 12.8years (SD ±2.24).

Standard	Gender				Total numbers	%
	Male	%	Female	%		
4th	46	11.5%	19	4.75%	65	16.25%
5th	44	11%	20	4%	64	16%
6th	41	10.25%	24	6%	65	16.25
7th	36	9%	31	7.75%	67	16.75%
8th	31	7.75%	38	9.5%	69	17.25%
9th	27	6.75%	40	10%	70	17.5%

Table 8: Numbers of subjects according to class wise and gender

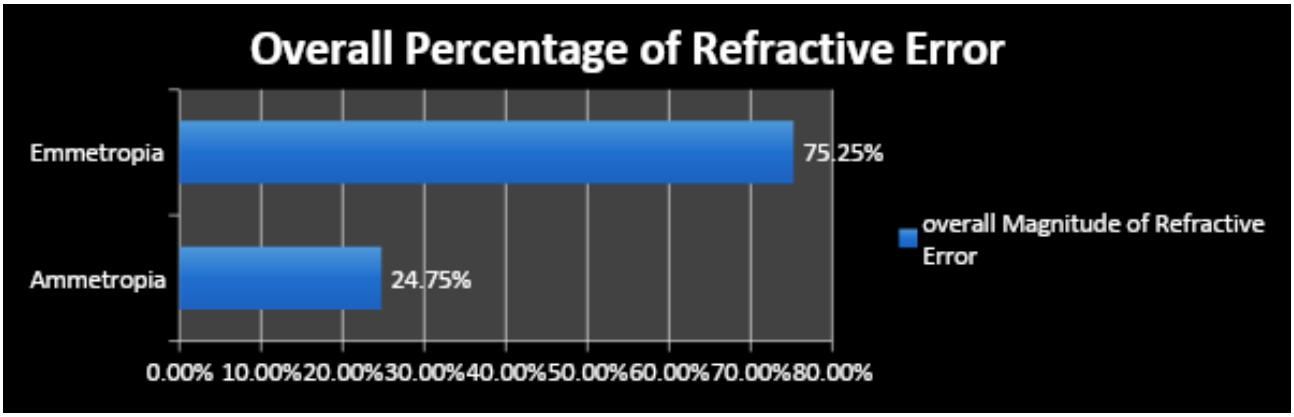


Figure: 1 Overall number of subjects with refractive error

Both categorized according to magnitude and percentage. Myopia was present in 51(12.75%) subjects, Hypermetropia was present in 17(4.25%) subjects and Astigmatism was

absent in 25(6.25%) subjects. Overall Astigmatism was presented in minus and plus both cylinder notation, defined as ≥ |±0.25 D| Hyperopia was defined as ≥± 0.50 D. Myopia was defined as ≥ |-0.50 D|. Emmetropia was defined as 0.25 D or less spherical equivalent refraction and is showed in the following table

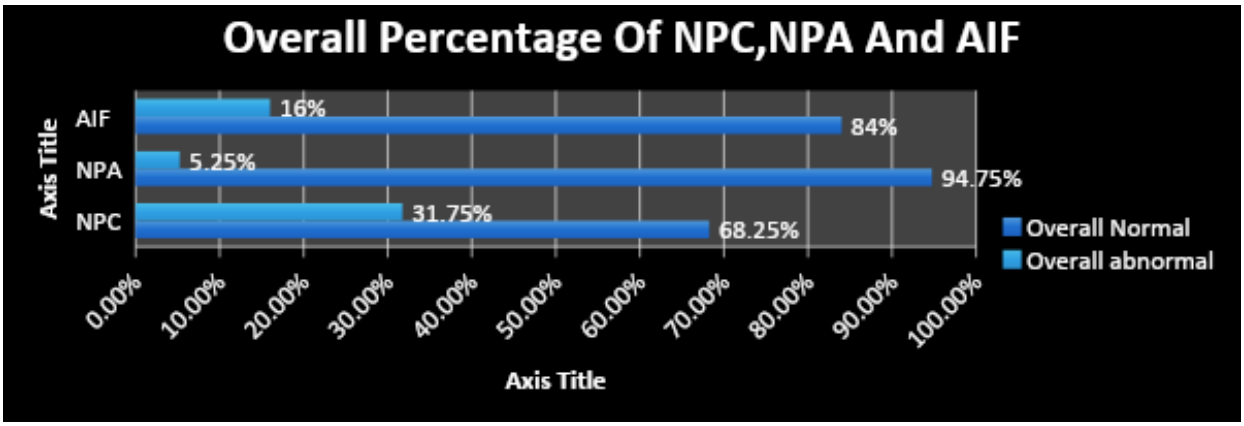
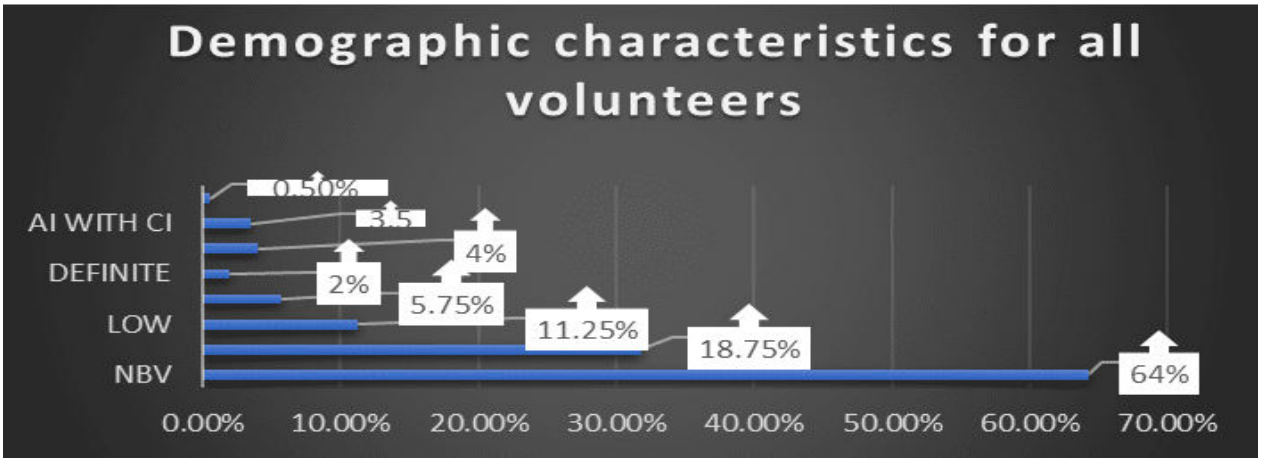


Figure: 3 Total number of subjects with NPC,NPA and AIF



Patients with symptomatic convergence insufficiency and Accommodative insufficiency report difficulty with near work, including blur at near and eye strain. Both categorized according to percentage. Convergence insufficiency was present in 19% subjects and absent in 81%. Accommodative insufficiency was present in 4% subjects and absent in 96%. CI and AI defined in figure

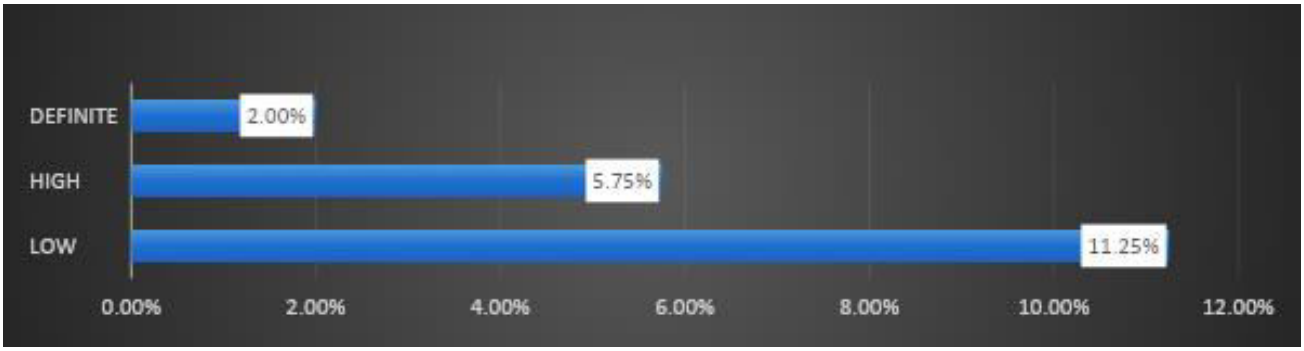


Figure :8 Number of subjects with convergence insufficiency

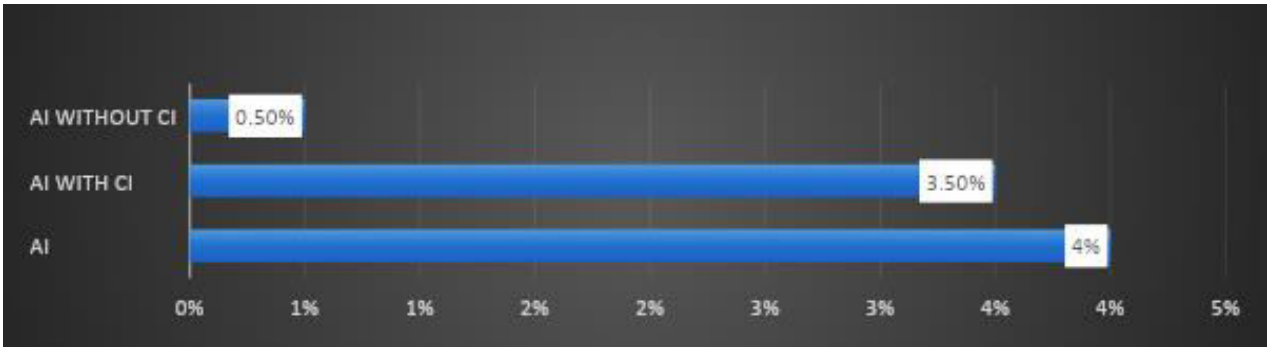


Figure:9 Number of subjects with Accommodative insufficiency

NSBVA in School children:

Between the 400 subjects,36% was NSBVA and 64% NBV. The most predominant findings among vergence dysfunctions were convergence insufficiency (127 subjects), Accommodative insufficiency (16 subjects) and Accommodative infacility (13 subjects).

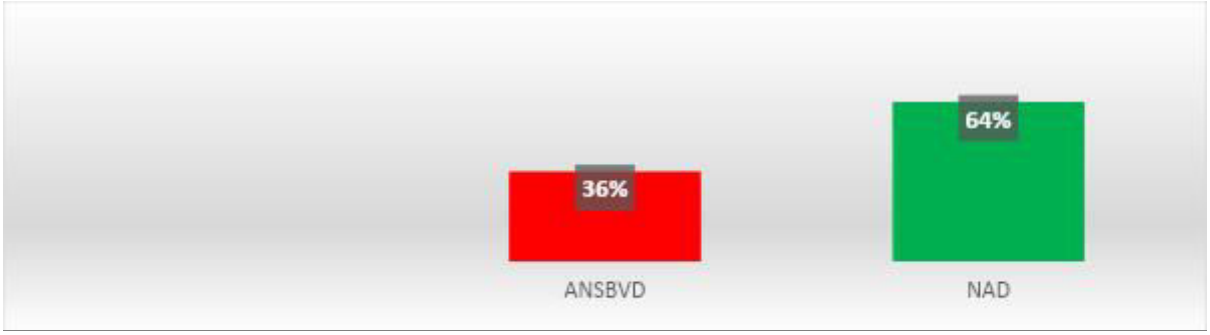


Figure: 10 Percentage of ANSBVD and NAD

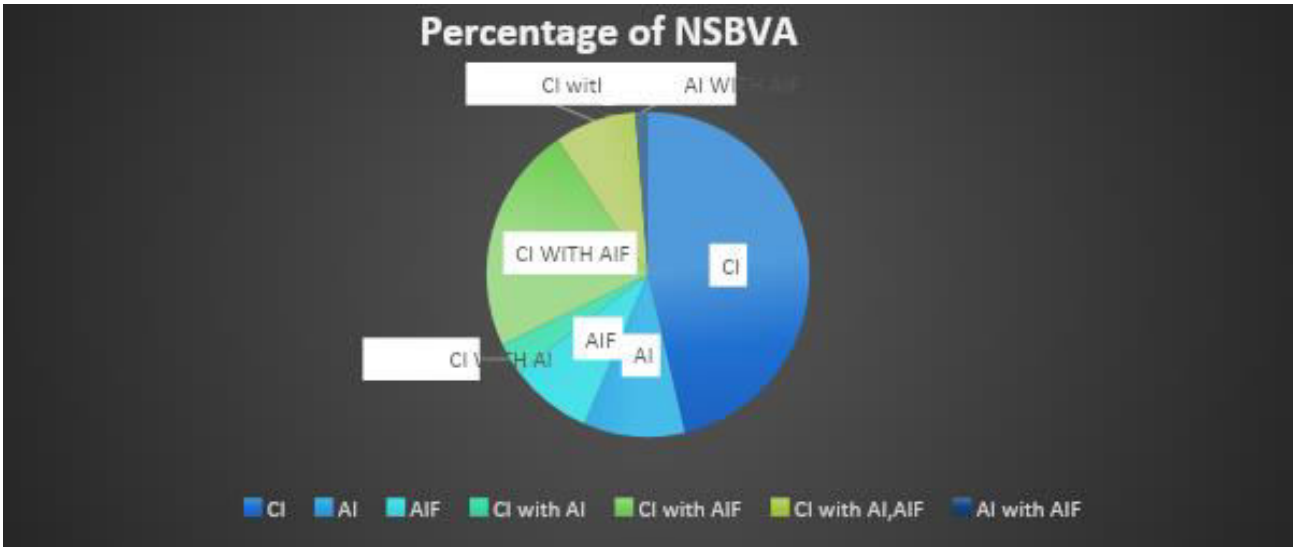


Figure: 11 Percentage of NSBVA

The eligible children (400), were grouped according to the classification criteria listed in in four main categories: children with Normal Binocular Vision (NBV), children with Convergence Insufficiency (CI), children with Accommodative Insufficiency (AI).

The demographic characteristics for all volunteers assessed and for each clinical grouping are expressed in Table Considering that of all the children assessed 127 revealed the presence of at least one criterion for diagnosing CI, it is estimated that 31.75% (**CI,CI with AI,CI with AIF and CI with AI and AIF**) and 18.25% only CI of children attending the 2nd cycle of elementary education have CI, but only 10 % (13/127) of these present a diagnosis of the dysfunction in its definite form. We found a rate of 13.5% CI in high suspect and definite forms and 11.25% low suspect.

It should also be noted that 16 students presented signs of AI (~4%) and 5 of these cases presented signs of CI with AI.

Category	**Total numbers(N)**	**%**	**Male(N)**	**%**	**Female(N)**	**%**
Convergence insufficiency (CI)	73	18.25%	34	8.5%	39	9.75%
Accommodative insufficiency (AI)	1	0.25%	1	0.25%	X	-
Accommodative infacility (AIF)	13	3.25%	12	3%	1	0.25%
CI with AI	5	1.50%	3	0.75%	2	0.75%
CI with AIF	36	9%	21	5.25%	15	3.75%
CI with AI and AIF	13	3.25	7	1.75%	6	1.5%
AI with AIF	2	0.5%	2	0.5%	X	-
Total	143	36%	80	20%	63	16%

Table 13: Total binocular anomalies

Visual condition	**N /%**	Gender	
		Male /%	Female /%
NBV	**257/64.25**	**155/60**	**102/40**
CI	**127/31.75**	**76/19**	**51/12.75**
Low	**73/18.25**	**45/11.25**	**28/7.00**
High	**40/10.25**	**23/5.75**	**18/4.50**
Definite	**13/3.5**	**8/2.00**	**5/1.25**
AI	**16/4.00**	**3/0.75**	**13/3.25**
With CI	**14/3.5**	**3/0.75**	**11/2.75**

Without CI	**2/0.5**	**-**	**2/0.5**

Table 16: The demographic characteristics for all volunteers assessed and for each clinical grouping are expressed in below in Table (visual condition in percentage and gender)

We found significant differences in expected values from the current clinical criteria for near point of convergence (NPC) with penlight, distance and near horizontal phorias, accommodative amplitudes, monocular and binocular accommodative facility (normal distribution $p < 0.001$). The mean and standard deviation of break values for NPC (in centimetres) with an accommodative target and penlight with red filter was 7±2 and 12±3 respectively. The mean accommodative amplitudes for the population could be estimated by Hofstetter with the minimum amplitude of accommodation as 18-(0.30 × (age in years). Monocular accommodative facility was 9±2 and 10±2 cycles/ minute and binocular accommodative facility was 11±2 and 11±2 cycles/minute in the 7 to 11 and 12 to 17 age groups, respectively. The mean and standard deviation of break values for PFV (in near) 22± 6 and (distance) 19±4 prism dioptre and break values for NFV (In near) 21±5 and (distance) 9±3 prism dioptre respectively.

It is inferred that there is significant differences among the male and female students for pushup and penlight. The Mean rank score of pushup for female students is comparatively lower than the male students and Mean rank score of penlight for female students is comparatively lower than the male students.

It shows that the perception of penlight is higher for male than female students. The pushup for the male and female students has no significant difference. (p=0.32) and age (p=0.38)

The mean rank (i.e. the Mean rank column in the Ranks table) of the pushup and penlight for each group, Kruskal Wallis test H test. That is the **chi- squared** freedom (the **df** row) of the test and the statistical significance of the test (the **Asymp. sig** row)

A Kruskal – Wallis test showed that there was a statistically significant difference in penlight between male and female group, p= 0.005, Chi-square =7.725 and df = 1

The results of the analysis indicate that there is a significant difference in the medians (12) N= 400, P= 0.005. Because the test is significant. And the pushup statistics P= .476 (Because p value is greater than 0.005) Chi- Square = .508 and df= 1

The results of the analysis indicate that there is a not significant difference in pushup between male and female group.

DISCUSSION

The present study reports frequency of CI and AI in a Gorakhpur A.K Ideal UP East (India) school-based sample. This study is unique in that we included students with significant refractive error and conducted testing with significant refractive errors. This is an important aspect of our design, as it has been reported.

- This study revealed a frequency rate of CI in children of the 4th to 9th year of school that varied between 3.5% for a more conservative diagnosis, requiring the presence of the

three criteria, to 18.25% for a more liberal diagnosis, requiring the presence of only one criterion. An intermediate prevalence of 13.75% can be considered if clinically significant CI (high suspect and definite categories) cases are accounted.

Our results are closer to the results obtained by (White and Wajuihianand and Hussaindeen et al.,2016) which are related to prevalence studies in different geographic areas and countries with different degrees of development.

The CI rate found in this study is somewhat lower than the results reported in other studies with similar methodology. For the most significant forms of CI (high suspect and definitive), the rate of occurrence was 13.75%, while in other 2012 studies rates ranging from 7.75 to 20% were found(L.F.Marran, P.N.DeLand et al., 2016).

Regarding the frequency of AI, a rate of comorbidity with CI not as high as that suggested by Rouse, nor as low as that proposed by Wajuihian was found, with values similar to those found by (Marran ,BorstingE, Mitchell GL, Kulp MT, et al.,2012) CI prevalence studies are more frequent than AI, and thus the need for more AI research is stressed, as proposed (Iribarren R, Fornaciari A, Hung GK et al.,2001).

It is interesting to note that a study by Rouse et al.22 revealed that near point of convergence is often used as the sole means of diagnosing convergence insufficiency in clinical practice. Near point of convergence (along with binocular accommodative facility) has also been reported to have the best diagnostic validity for identification of symptomatic.

The ability of common tests of alignment, vergence and accommodative function was evaluated to identify children with convergence insufficiency. Although measures of vergence and alignment were included in the classification of convergence insufficiency, these results show which of these commonly used tests.

Perform best in identifying children with convergence insufficiency in a screening setting when it may only be possible to perform one test. Near point of convergence break consistently achieved one of the highest areas under the curve for detection of convergence insufficiency and was, therefore, one of the best tests for identification of convergence insufficiency in a screening setting. A near point of convergence break ≥ 6 cm had the best sum of sensitivity and specificity for identifying children with convergence insufficiency (2–3 signs of convergence insufficiency, three signs of convergence insufficiency) while a near point of convergence break ≥ 10 cm generally had the highest sum of sensitivity and specificity for symptomatic convergence insufficiency. The near point of convergence cut-point of ≥ 6 cm is in agreement with the 10 cm cut-off used for convergence insufficiency classification in the CITT16 and both cut-points are in accord with the 6–10 cm cut-off for school screenings recommended by (Hayes etal). For detection of convergence insufficiency with three signs, the ratio of positive fusional vergence over the phoria also performed among the best tests, but this would require testing both positive fusional vergence and phoria and determination of the ratio. Amplitude of accommodation was among the best tests for detection of symptomatic three signs of convergence insufficiency.

The data indicates that frequency rates for clinical signs of CI and AI observed in Gorakhpur school children are higher than studies of other school-age samples when similar

clinical criteria are applied. It is possible that this difference across studies accurately reflects a higher rate of clinical signs of CI and AI in this Gorakhpur student population. However, it is also possible that some of these differences across studies are due to methodological differences, as previous studies excluded students with significant refractive error and/or poor acuity (Borsting E, Mitchell GL, Kulp MT, et al,2012.,) excluded students with significant refractive error if they were not currently wearing correction (J. E. Letourneau and S. Ducic,et al,.1988)or did include students with refractive error but did not report the number of children with refractive error tested with or without correction(Iribarren R, Fornaciari A, Hung GK et al .,2001)

When a more strict clinical diagnostic criteria for CI is used (i.e., presence of 3, rather than either 2 or 3, clinical signs) frequency rates are much lower. When presence of symptoms is included in diagnostic criteria, frequency of symptomatic CI was 18.25%(3.0 %without AI) and symptomatic AI 4%(0.5%without CI).. It is possible that our rates of symptomatic CI and AI are over estimated because although all students in the targeted grades were eligible to participate, symptomatic students may have been more likely to enrol in the study. In addition, AI results should be interpreted with caution as the classification of AI was made utilizing a single measure, whereas NPC and PFV for assessment of CI were measured 3times (with the mean used in analyses.

In summary, we observed that Gorakhpur school children appear to have higher rates of clinical characteristics associated with CI and AI. It is not clear if this finding is due to methodological differences across studies or if there is simply a higher rate of CI and AI in this population of students.

Table 18: Rate of CI and AI age range between 7 and 19

Study (author/year	country	Age groups	Sample size	Prevalance CI(%)			Prevalance AI (%)	
				Low	high	definite	With CI	without CI
Rouse et al /1998	USA	8-12	428	33	12	6	-	-
Menjivar et al/2018	USA	9-14	282	-	19.8	-	8.2	-
Borsting et al 2003	USA	8-15	392	10.5	12.7	4.6	-	10.5
Wajuhian and Hansraj/2016	South Africa	13-19	1211	11.8	6	4.3	1.9	-
Marran 2006	USA	11.5±0.63	299	-	18	-	3.3	4.7
Hussaindeen et al/2016	India	7-17	920	-	16.5	-	0.2	-
Present study	India	7-17	400	18.25	10.25	3.5	3.5	0.5

It is important to highlight the greater intensity of symptoms in children with these syndromes, especially those with an accommodative insufficiency. Other authors have also reported this relationship, noting that accommodative changes are more symptomatic than changes in convergence, (Borsting E, Mitchell GL,KulpMT, et al 2012.,). In addition, studies that have investigated the relationship between the intensity of near-work and visual complaints,

found an association between the cumulative amount of near work, decreased accommodative facility and increased asthenopia (J. E. Letourneau and S. Ducic.et al. 1988).

The main limitations are lack of resources and in many poor rural districts, there is a dramatic lack of eye-care services, and, even where they are available, their quality is not always satisfactory. Lack of awareness among parents and the community about Non strabismic binocular anomalies and refractive error and that the vision of children. Shortage of paediatric eye-care professionals. Insufficient data on the prevalence and types of refractive errors and Non strabismic binocular anomalies in different populations and age groups. Lack of qualitative research on the impact of refractive errors on quality of life, visual function and economic productivity. Insufficient evidence about the most cost-effective ways of delivering refraction services in different settings; and underestimation by health-care providers and policy-makers of the extent and potential socioeconomic impact of uncorrected refractive errors in the community.

CONCLUSION

It is estimated from this study that the frequency of CI in Gorakhpur children aged between 7 and 17 years old, is slightly lower than the frequency of the same ages reported in other developed countries. The frequency of clinically significant CI (two or more signs) was only 13.5%. Comorbidity with AI was also identified and with rates similar to those reported in the literature. However, an AI rate (with and without CI) was slightly lower than the rate of significant CI (Rouse et al,.1998 and Marran et al,.2006).

The normative data for convergence and accommodative parameters for the Indian children between 7 to 17 years of age are reported (Hussaindeen et al,.2016). The developmental trend of accommodation and vergence differences and significant differences in cut-off between the current data and available literature are reported. These differences have clinical implications for the interpretation, diagnosis and management of anomalies of binocular vision. Kids and teenagers with headache complaints, while reading, loss of concentration in performing near vision activities, among other visual stress complaints, must be submitted to an evaluation of binocular vision and accommodation status.

The study will also provide insight into the differences in binocular vision parameters between ethnicities, and the minimum battery of test needed to detect binocular vision anomalies in a community. The future scope of the study is to incorporate screening for BV anomalies as a routine in school vision screening program. Advocacy for the same will be carried out through awareness sessions and educational materials to patient and practitioner. The normative data for binocular vision parameters would be extended to age group beyond age 17 so as to understand the changes in BV parameters longitudinally in a cross-sectional..Also, prevalence estimates in the higher age group need to be understood. Vision-related quality of tools such as the CISS and ABS demand validation and modification and this will be carried out in our ethnicity. Innovative delivery models and tools for vision therapy in a community set-up will be further explored. To determine normative data of binocular vision parameters among school children. To estimate the

prevalence of binocular vision (BV) anomalies among school children in rural Gorakhpur. To arrive at the minimum test battery needed to pick up binocular vision anomalies in a community setting.

To provide vision therapy to children identified to have binocular vision anomalies and to assess the impact of vision therapy on quality of life and reading performance after vision therapy. Also as a part of this study, estimating the prevalence of convergence insufficiency in the hospital based set-up was also carried out.

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