ASSESSMENT OF BINOCULAR MOTOR ANOMALIES AND VISUAL PERCEPTUALSKILLS IN SCHOOL GOING CHILDREN AND SPECIAL POPULATION

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Abstract

Purpose: To report the frequency of binocular motor anomalies & visual perceptual skills innormal school going children & special population

Method: The study was carried out at Sarswati school, at Little Heart Special school & Nistha Special school New Delhi. Comprehensive eye examination, binocular vision assessment & visual perceptual skills with TVPS-R was carried out for 45 children in normalschool & for 45 children at special schools. BV assessment was done for children with best corrected visual acuity of ≥6/9 :N6, cooperative for examination as well as free from any ocular pathologies

Result: A total of 64% have normal binocular vision, 29% have AI (accommodative insufficiency). Majority 3% have CI (convergence insufficiency) and 5% have AI with CI in normal population as well as showed that among the participants the majority 51% have AI, 49% have CI in special population. Visual perceptual skills were 37(82%) have good visual perceptual skills and 8(18%) have poor visual perceptual skills in normal population and 22% have good visual perceptual skills and 78% have poor visual perceptual skills in special population. Comparison of binocular motor anomalies and visual perceptual skills in normal &special population shows p – value <0.001 (paired t- test).

Conclusion: Non-strabismic binocular vision anomalies are highly prevalent among school children and the prevalence increases with age. With increasing near visual demands in the higher grades, these anomalies could significantly impact the reading efficiency of children. Thus, it is recommended that screening for anomalies of binocular vision should be integratedinto the conventional vision screening protocol.

Keywords: Converge Insufficiency: Special Population; Visual Perceptual Skill: Non-Strabismic Binocular Vision Anomalies: Accommodation Anomalies

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1. Introduction

Other than refractive anomalies, accommodative and binocular vision problems are the most common visual disorders in the clinical paediatric population. These dysfunctions are termed under a broad umbrella 'non-strabismic binocular vision anomalies' (NSBVA) and the expected findings or normative data for binocular vision and accommodative testing used for the diagnosis and classification of NSBVA vary by ethnicity. The most commonly used criteria are those reported by Morgan6 and Scheiman and Wick.7. (Hussaindeen, et al., 2016)

In many cases, the cause is an abnormality in any of the accommodative and/or vergence systems, which can lead to the development of what are termed accommodative and non- strabismic binocular dysfunctions. Accommodative and vergence dysfunctions can interfere with a child's academic progress or a person's ability to function efficiently in the course of his or her work. Children may abandon a task due to their inability to maintain adequate accommodation and/or vergence in the plane of fixation. These dysfunctions are commonly encountered in clinical practice and present a variety of associated symptoms, including blurred vision, difficulty in focusing at different distances, headache and ocular pain, among others. (García-Munoz, et al., 2014)

In a study by Lara et al, (2001) to determine the prevalence of nonstrabismic accommodative and binocular dysfunctions in a clinical population, among 265 they found the prevalence of binocular dysfunction was 12.9% and 9.4% for accommodative anomalies. Convergence excess was 4.5% and was more prevalent than convergence insufficiency 0.8% and accommodative excess was 6.4% and was more prevalent than accommodative insufficiency 3%. (Lara, et al., 2001)

In a study by Esteban et al., in 65 students without noticeable refractive error, amblyopia or strabismus and there was noticeable binocular disorder in 32.3 %. There were convergence insuficiency in 7.7 % and basic exophoria in 3.1 %. (Porcar & Palomera, 1997)

In study by Montes-Mico to determine the prevalence of general dysfunctions in binocular vision in a nonpresbyopic in 1679 subjects aged 18 to 38 years, the prevalence of convergence insufficiency was 5.9 %. 11 In study by Cacho-Martinez et al., the prevalence of CI was 2.25%-33 %. (Montés-Micó, 2001)

In a study by Hussaindeen , prevalence of Non-strabismic binocular vision anomalies in the pilot study (n=100) was 46%. The most prevalent NSBVA was convergence insufficiency (32% in the overall population and 69.5% among the NSBVA) followed by accommodative infacility (10% in the overall population 21.7% among the NSBVA). (Hussaindeen, et al., 2015)

Special Population

Special children have disability or a combination of disabilities that makes learning or other activities difficult. Children with learning disabilities are neurological – based processing problem. These problems can interfere with learning basic skills such as reading, writing & or/ math. (Hussaindeen, et al., 2017)

Learning Disability means disorder in one or more of the basic psychological processes involved in understanding or using language, written or spoken, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations. The term includes such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. Learning disabilities may represent a deficit in one aspect of learning but more commonly affect multiple areas of functions. Learning disabilities in mathematics (dyscalculia) are rarely the principal cause for referral. Most often they are seen in conjunction with deficits in either reading or written expression. (Shapiro & Gallico, 1993)

Learning disorders are very common among primary school pupils, so they need a lot of care and attention in this regard because in this stage learning disorders recognized (Specht, 2004). Children with learning disorders aren't able to compete with their peers in some educational fields, while in some field do better than their peers. Learning disorder will lead to no progress in education, this is not expectable based on children's abilities and educational opportunities. Approximately, 4% of children in U.S.A suffer from reading disorder. Studies show that prevalence of this problem is 2- 8%. Learning disorders mostly refer to boys more than girls because of behavioural problems (Margalit, et al., 1997).

In India, the reported prevalence of specific learning disabilities is 15.17% among 8-11 years old children. As reading is a primary concern under the SLD, it also raises concern about the efficiency of the visual system that could contribute to the reading impairment (Hussaindeen, et al., 2017). Depending on the diagnostic process and the definition used, estimates of the prevalence of learning problems among school-aged children range from 2% to 10%. Nationally, about 5% of all schoolchildren are diagnosed with learning disabilities (and an equal or higher number have milder learning problems). Of that population, as many as 75% have reading problems (Scheiman & Wick, 2014).

It has been estimated that 80% of children with specific learning difficulties have a poor ability to read. These children should be assessed by the ophthalmologist because some of these children may have treatable visual problems that accompany or contribute to their primary reading or learning disabilities (Muzaliha, et al., 2012)

The causes of learning disabilities are unknown. Affected children do not seem to have an increased incidence of birth trauma or other environmental influences. Reading disability doesseem to have an origin in language-related brain regions, however. Neuropathologic and imaging studies of adults and children with dyslexia have noted a lack of the normal asymmetry in the area of the planum temporale of the temporallobe. The neuropathologic studies also have found developmental abnormalities (dysplasias and ectopias) in other areas of brain, more on the left than on the right.

In addition to developmental brain alterations, genetics also plays a role; often several membersof a family have a language-based learning disability. Several possible chromosome linkages have been identified in inherited dyslexia, but none has been confirmed and doubt has been expressed that a single major locus could account for all learning disabilities in reading. Children with certain X chromosome syndromes (girls with Turner syndrome or fragile X syndrome and boys with Klinefelter syndrome) have a greatly increased risk of non-language- based learning disabilities (Shapiro & Gallico, 1993).

Visual-Perceptual Skills

Visual perception refers to the process of organizing and interpreting visual sensory stimuli. As such, it would appear to be an important correlate of reading ability (Kavale, 1982).

visual perceptual (VP) problems are well recognized sequelae of many conditions including periventricular leucomalacia, cerebral palsy and hydrocephalus. VP abilities improve during infancy and childhood in normal development but development may be delayed or impaired in neurogenetic disorders such as Williams syndrome. Deficits in visual perceptual abilities may coexist with other neurodevelopmental problems such as reduced performance in intelligence tests, or may be isolated and unassociated with other cognitive deficits (Williams, et al., 2011).

Visual perceptual skill is subdivided into areas, visual discrimination and visual memory. Visual discrimination involves ability to attend and identify a figure’s distinguishing features and details, such as shape, orientation, color and size. Visual is ability to remember a visual image. For example, good visual discrimination could assist children in discriminating between numbers, differentiating between arithmetic signs, and breaking down problems into manageable components. In addition, good visual discrimination and visual memory skills would be helpful when spatially organizing calculations or solving geometry and workproblems. Furthermore, good visual memory skills could also be instrumental when learning multiplication tables, retaining what has been read in a word problem, and copying assignments from the board to the paper (Kulp, et al., 2004).

TEST FOR VISUAL PERCEPTUAL SKILLS (TVPS-R)

In the 1970s and 1980s, several standardised tests of visual perception were developed: (1) theMotor-Free Visual Perception Test (Colarusso & Hammill, 1972), (2) the Test of Visual Perceptual Skills (non-motor) (Gardner, 1982), and (3) theTest of Visual-Motor Skills (Gardner, 1986). Subsequent to their development, a number of these instruments were revisedand updated in the 1990s: (1) Motor-Free Test of Visual Perception—Revised(Colarusso & Hammill, 1996), (2) Developmental Test of Visual Perception—2 (Hammill et al., 1993), and
(3) Test of Visual Perceptual Skills (Non-Motor)—Revised (Brown, 2008).

This third edition covers the age range 4 through 18 previously served by two earlier editions (TVPS- R and TVPS-UL-R). The TVPS-3 is an easy-to-use assessment to determine a child’svisual perceptual strengths and weakness.

The TVPS-3 includes the following subtests:

Visual Discrimination: is the ability to be aware of the distinctive features of forms, including shape, orientation, size and colour. This ability is necessary in determining same from different. Visual discrimination problems may result in the person confusing words with similar beginnings or endings and even entire words.

Visual Memory: is the ability to retain written information over an adequate period of time. This is essential for reading comprehension and spelling.

Visual-Spatial Relationship: is the ability to find out the correct or similar form from the given five forms.

Visual Form Constancy: is ability to find out the correct form from the given five forms, eventhough it may be smaller, bigger, darker, turned, or upside down.

Visual Sequential Memory: is ability to find out the similar form in a adequate period of time.

Visual Figure Ground: is the ability to concentrate on a specific feature or form while maintaining awareness of the relationship of this form to background information

Visual closure: is the ability to be aware of the clues in the visual stimulus that allow a final perception to be determined without the necessity of having all the detail present (Jill K. Schultz, 2017).

2. Methods

In this cross – sectional study was conducted during the period of Feb. 2019 to March 2020 in Delhi NCR India. Full comprehensive eye examination was done for all subject followed by binocular vision (BV) evaluation. BV evaluation included the following measurements.

This study involved 90 subjects aged 5 – 15 years where 45 subjects were from normal school going children and 45 from the special school. Taking into consideration, all the subjects were enrolled after the informed consent. All the subjects underwent a detailed ocular examination by clinically experts followed by the ophthalmologists. Demographic data which included name, age, gender, education, of the subjects. The condition of the subjects was noted on the basis of parent's and the teacher's report and records available in the schools about each subject.

Detailed history was taken for each subject which included ocular history, family history, systemic history, history of any trauma as well as history of any allergy. Also, subjects were asked about any previous ocular diagnosis and any documents they were having for that. At the same time, they were also asked about the chief complaints they had at that time.

Visual Acuity was assessed using distance Bailey-Lovie chart: designed with constant size progression ratio, each row having the same number of letters. The chart designed on a logarithmic basis and visual acuity designated in terms of logarithm of the minimum angle of resolution or Log Mar. visual acuity was assessed taking the chart at sufficiently close distance at which subjects were able to read the letters on the chart and later correction factor was applied based on the testing distance at which subjects responded.

Distance Visual Acuity was also assessed with multiple pin hole to understand the visual prognosis of the subjects.

At the same time LVRC near visual acuity chart was used at 40 cm for near vision assessment chart was moved closer to subjects at sufficiently closer distance at which they were responding if they were not able to read at 40 cm.

Retinoscopy was performed with the help of Heine retinoscope, trial frame & trail lenses. Radical retinoscopy was done in case of any opacities in media where retinoscope reflex was difficult to get. In this method, retinoscope was moved to whatever distance was necessary (i.e. 33,25, or 20 cm) to obtain a retinoscope reflex and later the appropriate working distance lens power (i.e. 3.00, 4.00, or 5.00D) was deducted from the findings to get the exact values.

Subjective refraction was done based on objective findings as well as bracketing technique was also used for the same in some subjects where objective refraction was not possible. Chart wasplaced at 10 feet distance. In this bracketing technique, subjective testing was started with

+6.00 D, plano, and -6.00 D lenses, with succeeding lens powers being used to "bracket" the subject's refractive end point. Abrupt lens changes were made as the subjects were not expected to respond to lens change as low as 0.25D or even 0.50D.

Anterior segment of eye was assessed with the help of torch light Lids, conjunctiva, cornea, anterior chamber angle, iris, pupillary reaction and its contour etc was assessed grossly of all subjects.

Direct ophthalmoscopy was done using Heine ophthalmoscope for posterior segment evaluation. Basically, Optic disc as well as macular area was evaluated.

Appropriate referrals were made for the children who needed further ophthalmic evaluation. A copy of referral letter was sent to the parents and school administration if the child needed to be referred for ophthalmic evaluation. The binocular vision testing was carried out with the best corrected refraction in place. If the subject was found to have refractive error for the first time or if a change in refractive error of more than 0.50 D was detected during the refraction, glasses were prescribed and the subject was enrolled after 2 weeks of refractive adaptation.

Binocular vision testing included:

Sensory evaluation for near: Using Randot stereo plate.

1. Motor evaluation: Motor evaluation comprised of (a) phoria and ocular motility testing, (b)accommodation testing, (c) vergence testing and (d) oculomotor testing.

(a) Phoria and ocular motility testing: Assessment of phoria or tropia was done using cover/uncover test and angle of deviation was neutralized using prism bar cover test. Extraocular eye movements were assessed using broad H test and versions were assessed in nine cardinal gaze positions.

(b) Accommodative testing: The amplitude of accommodation was measured monocularly and binocularly using the push-up test. Monocular values less than 2 dioptres from Hofstetter's minimum expected criteria (15---0.25 (age)) were considered to be abnormal.

Accommodative facility (AF) was assessed in cycles per minute (cpm) both monocularly and binocularly using +2.00/−2.00 D accommodative flipper lenses at 40 cm. Simple three letter words of N8 font size were used as test targets. Monocular AF of 7 cpm for 10---13 years and 11 cpm for greater than 13 years were considered normal.

Monocular estimate method (MEM) retinoscopy was used to assess the accommodative response and a normal lag was considered to be between +0.25 to +0.75 D.

(c) Vergence testing: Near point of convergence (NPC) was assessed using an accommodative target and diplopic response as the target is brought closer was taken as the subjective response.

Objective measurement of eye deviation was also noticed and the test was repeated twice to assess the consistency of responses. NPC break ≥6 cm was If the subject was unable to determine the answer on plate A, the correct form was pointed & explained the proper answer & was marked on the considered to be abnormal. Fusional vergence amplitude was measured with prism bar (step vergence) for both distance and near. The negative fusional vergence (NFV) was assessed first followed by positive fusional vergence (PFV). Normative values for diagnosis and diagnostic criteria for NSBVA were adopted and modified from (Scheiman & Wick, 2014).

(d) Oculomotor testing: The developmental eye movement (DEM) test was used to evaluate visual---verbal oculomotor dysfunction. The DEM test consists of three subtests: a pre-test, vertical subtest and horizontal test. The vertical subtest depends on the individual's visual verbal automatic skills. The horizontal subtest consists of numbers arranged in non- symmetrical horizontal array that assessed the horizontal saccadic function.

TEST FOR VISUAL PERCEPTUAL SKILLS (TVPS-R)

Visual Memory (VM): Subjects was asked to "look at the form & remember it so that he/shecan find it on another page". (pointing to the form, which is a single item, plate A). The subjects were asked (after turning the page) "find it among these forms".

record form, the number corresponding was the subject's incorrect response.

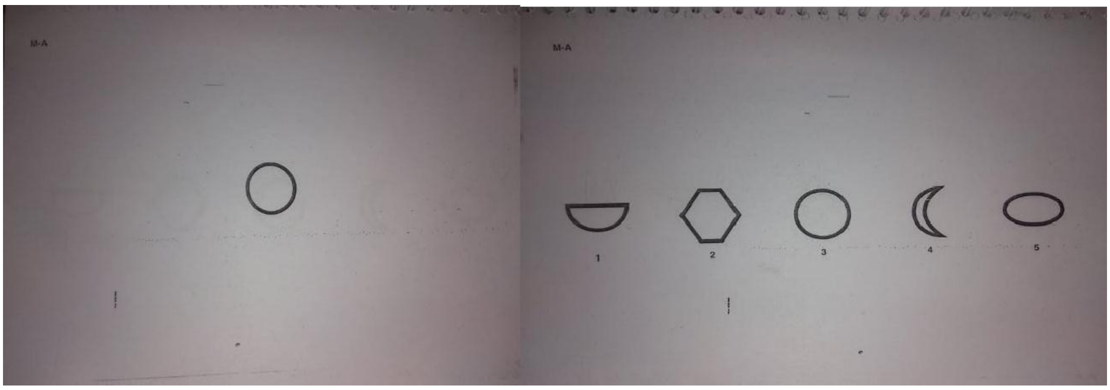


Figure1: test plate of visual memory

Visual concentration (visual form constancy): Subjects was asked to "look at the form" (pointing to the single form above the other five forms on plate A). Then the subjects were asked to "find the form among five forms even though it may smaller, bigger, darker, turned or upside down".

If the subject was unable to determine the answer on plate A, the correct form was pointed & explained the proper answer & was marked on the record form, the number corresponding was the subject's incorrect response.

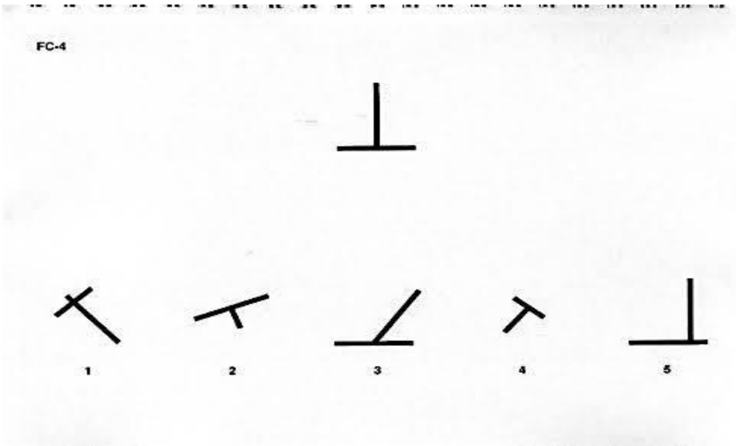


Figure 2: Test plate for visual concentration

Isual discrimination (VD): The subjects were asked to "look at the form (pointing to thesingle form above the other five forms below" (pointing to the five forms below).
If the subject was unable to determine the answer on plate A, the correct form was pointed &explained the proper answer & was marked on the record form, the number corresponding was the subject's incorrect response.

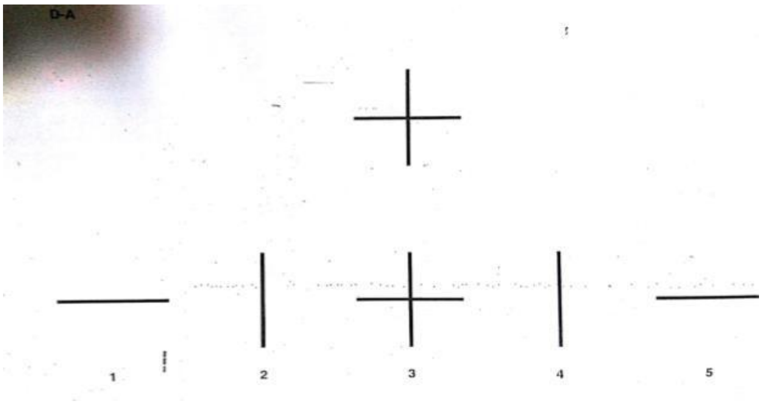


Figure 3: test plate for visual discrimination

Visual closure (VC): The subjects were asked to "look at the form" (pointing to the completed form on plate A). Then subjects were asked to the one form that would be like theform above, if completed.
If the subject was unable to determine the answer on plate A, the correct form was pointed &explained the proper answer & was marked on the record form, the number corresponding was the subject's incorrect response.

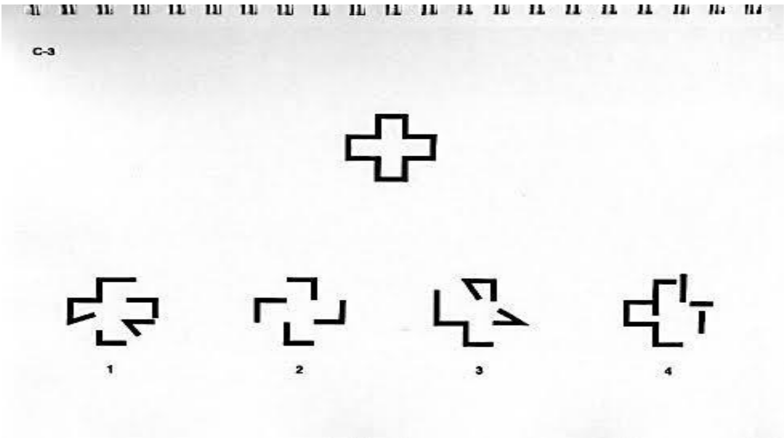


Figure 4: test plate for visual closure

3. Results

In this study, subjected were included out of which 47% were female, and 53% were male. Majority 47% of the participants were belonged to the age group 10-12 years, 53% were from13-15 years of age in school going children and among subjects from special population, 51% participants were female, and 49% were male. Majority 60% of the participants were belonged to the age group 10-12 Years, 40% were from 13-15 Years of age. 64% have normal binocular vision, 29% have AI. Majority 3% have CI and 5% have AI with CI in school going children and 51% have AI, 49% have CI in special population. 37(82%) had good visual perceptual skills and 8(18%) had poor visual perceptual skills in school going children and 10(22%) had good visual perceptual skills and 35(78%) had poor visual perceptual skills in among special population.

Table 1Frequency distribution of participants as per demographic profile in normal population.

Demographic Data			
Parameters		**Frequency**	**Percentage (n=100)**
Gender	Male	24	53%
	Female	21	47%
Age (Years)	10-12	21	47%
	13-15	24	53%

Table 2 Frequency distribution of participants as per demographic profile in special population.

Demographic Data			
Parameters		**Frequency**	**Percentage**
Gender	Male	22	49%
	Female	23	51%
Age (Years)	10-12	27	60%
	13-15	18	40%

Figure 1 Frequency and percentge distribution of binocular motor anomalies in normal population.

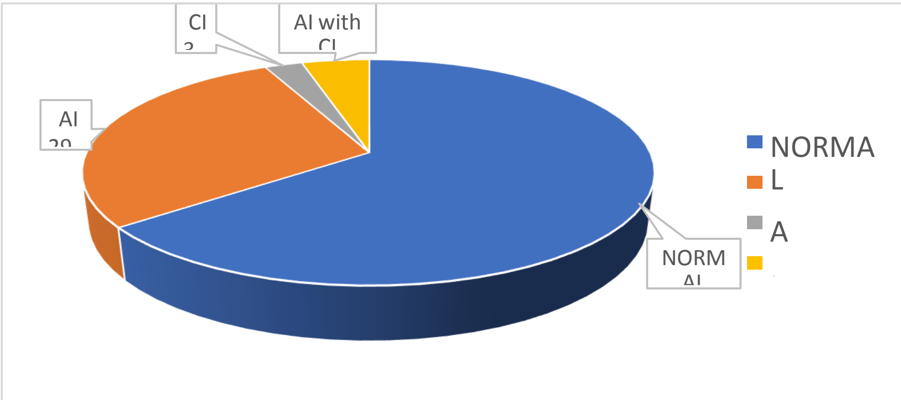


Figure 2 Frequency and percentge distribution of binocular motor anomalies in special population

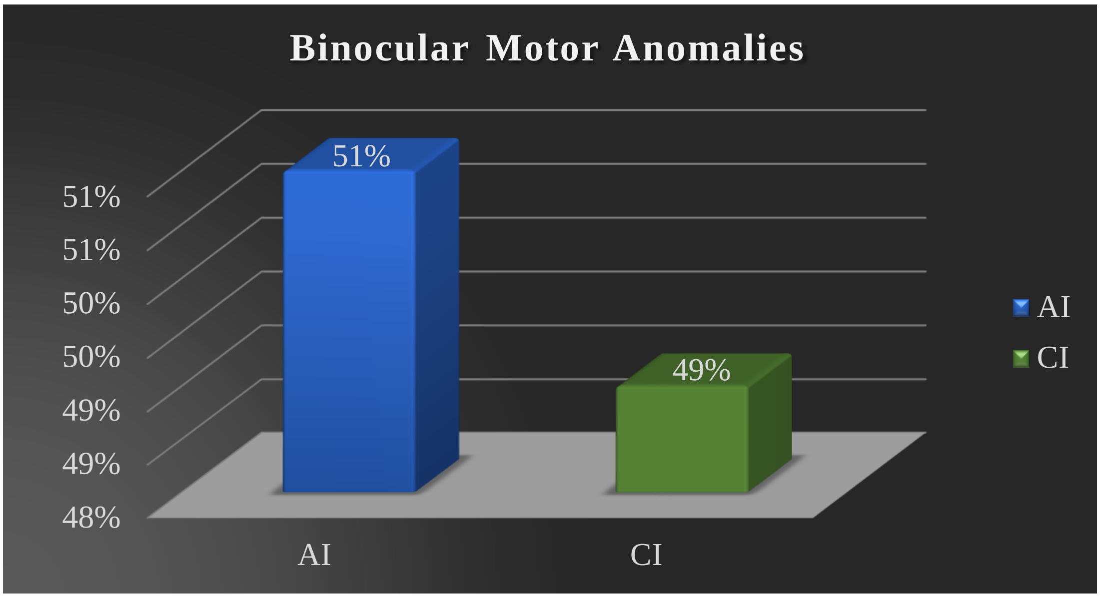
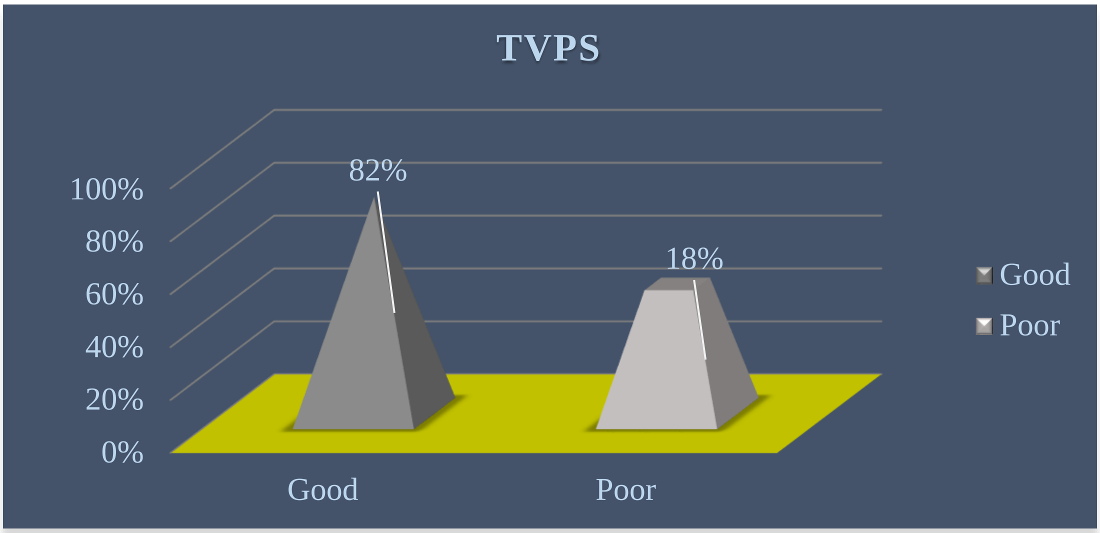


Figure 3 Frequency and percentages of Visual perceptual skills distributions in normal population



(Hussaindeen, et al., 2016)

Figure 4 Frequency and percentages of Visual perceptual skills distributions in special population

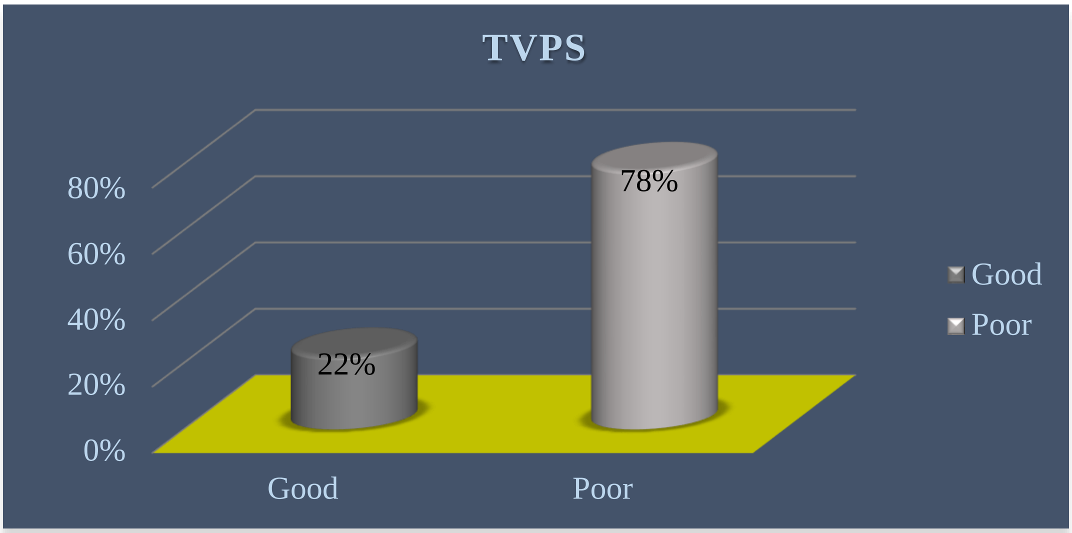


Table 3 Association of binocular motor anomalies of demographic profile in normal population.

Demographic	d.f.	P-Value	Chi Square Calculated Value	Chi SquareTable Value	Inference
Gender	3	0.14	5.45	7.82	No association
Age	3	0.67	1.53	7.82	No association

In all the p values were more than 0.05 so no any demographic variable is associated withbinocular motor anomalies among normal population.

Table 4 Association of binocular motor anomalies of demographic profile in special population.

Demographic	d.f.	p-Value	Chi Square Calculated Value	Chi SquareTable Value	Inference
Gender	1	0.88	0.02	3.84	No association
Age	1	0.62	0.23	3.84	No association

In all the p values were more than 0.05 so no any demographic variable is associated withbinocular motor anomalies among special population.

Table 5 Comparison of binocular motor anomalies and visual perceptual skills

Group	N	Median	Minimum	Maximum	p value	Wilcoxon Signed Ranks statistic
Normal population	**45**	**38**	**22**	**54**	**0.001**	**27.0**
Special population	**45**	**24**	**10**	**43**		

Here the p-value is less than 0.05 so i.e. there is a difference between "Normal population" and"Special population".

4. Discussion

The discussion of the present study was based on the results achieved after the analysis of collected data. It is described in the view of the objectives of the current study.

Current study is supported by a study conducted by Mohd-Nor Muzaliha et al, "Visual acuity and visual skills in Malaysian children with learning disabilities." The finding shows that 62.4% were male and in my it was 53%. In another study AI was also found to have the highest prevalence in some studies García et al "evaluating the relative accommodations in general binocular dysfunctions." The finding shows that 39% were AI and, in my study, it was 29%. In another study which was conducted by Jameel Rizwana Hussaindeen et al and according to this CI was found in Hospital based studies in India, report prevalence rates of convergence insufficiency from 3.6 to 7.7 % and in my study, CI was 3%.

Research is the future of our optometry profession; it will lead us to an even higher recognitionand to a better professional position. It will lead us to a more optimize clinical practices. This kind of research will help in to find out prevalence of ophthalmologic disorders and their risk factors so it will be helpful for in the management of those disorders. This research study will help to nation's health policy makers to plan for various congenital and acquired ophthalmologic disorders management and to plan for various health program or schemes related to ophthalmologic conditions in special population.

This study was limited to find out prevalence only. This study was limited to only one-time data collection for eye examination Sample size was small. One assessment situation didn't replicate the scenario of "actual world."

5. Conclusion

Analysis and interpretation of the data are based on data collected from 90 samples. In that 45 samples were from normal population and 45 samples were from special population in Delhi. Analysis and interpretation of data is done by using descriptive statistics in that frequency and percentage distribution were calculated and for inferential statistics in that Chi square and Wilcoxon signed rank test were used based on objectives. There was no any association in demographic profile and binocular motor anomalies. In comparison between the level of visual perceptual skills in normal and special population was found, "there is significant statistical difference between normal and special population". In normal population majority was male participants and in special population majority was female participants.

A similar research study can be conducted with the large samples to generalised the findings. A pre-test post-test research can be carried out to assess the effectiveness of various therapy on visual perceptual skills in special population with learning disabilities. A comparative study can be conducted in two different geographical regions.

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Ethical approval: Ethical approval was done by the ethical committee of ITM University, Gwalior, Madhyapradesh, India

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