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Original Research Article

Prevalence of non-strabismic binocular vision anomalies (NSBVA) among university students of North India

Tsering Lamu Shongmu[1]*, **Zeeshan Akhtar**[1]

[1]*Dept. of Optometry, Sushant University, Gurugram, Haryana, India*

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ABSTRACT

Aim: To report the clinical profile of Non-Strabismic Binocular Vision Anomalies (NSBVA) among university students in North India.

Materials and Methods: A cross-sectional study was performed among 180 students of the university between the age of 17-35 years attending Sushant vision care center (SVCC), Gurugram from October 2017- February 2020. A comprehensive eye examination and a detailed orthoptic evaluation for binocular and accommodative dysfunctions was carried out, including sensory and motor examinations.

Results: 102 of the 180 patients were women and 78 were men. The mean age of the sample was found to be 21.8±2.3 years (mean±SD) with an age range of 17-35 years. The prevalence of NSBVA was found to be 62.2%, of which Convergence Insufficiency was found to be most prevalent (37.2%), followed by Accommodative Insufficiency (12.2%), Accommodative Infacility (7.2%), and Accommodative excess (5.5%). Out of the total, 89 students (49%) exhibited ocular symptoms, while the remaining 91 (51%) were asymptomatic; prevalent symptoms included eyestrain, headaches, and watering of the eyes.

Conclusion: The study reveals prevalent non-strabismic binocular anomalies among university students, with vergence dysfunctions being more prevalent than accommodating dysfunctions. Convergence Insufficiency is the most common. While some of these anomalies might lead to noticeable symptoms, others remain asymptomatic, potentially contributing to delayed diagnosis. Comprehensive eye exams are essential for university students, encompassing evaluation of accommodative and binocular functions alongside refraction to timely detection and treatment, including lenses, prisms, and vision therapy to enhance visual performance

1. Introduction

Non-strabismic binocular dysfunctions are the visual abnormalities which impair a person's binocular vision and visual performance, while reading at close distances.[1] It's arise due to Imbalance between the accommodation and vergence response to near task and leads to impaired near vision and visual discomfort which ultimately compromises efficiency at work place.[2] Multiple studies have shown a variety of NSBVA symptoms, including blurred vision, trouble focusing at different distances, headaches, ocular pain, and trouble focusing in particular when reading and writing.[3–5] Numerous research have shown that these dysfunctions are frequently seen in optometric practice, however there is a significant difference between the prevalence estimates provided by various authors.[6–9] The variability is mainly explained by diverse study populations and diagnostic criteria. The three most frequent anomalies in optometric practice are untreated refractive errors, accommodating binocular disorders, and non-strabismic binocular disorders.[10,11]

* *Corresponding author*.
E-mail address: lamushongmu@gmail.com (T. L. Shongmu).

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Undiagnosed binocular vision impairments and Oculomotor dysfunctions can manifest as discomfort, leading to adverse effects on both clinical training and academic performance.[3,12–16] Non-strabismic abnormalities related to binocular vision are notably widespread among school-age children.[6] The most frequently encountered issue is convergence insufficiency, closely followed by accommodative infacility.[17] Notably, accommodative and binocular vision issues are the next most prevalent group of visual impairments among clinical paediatric patients, only following refractive anomalies.[17]

Nowadays in our changing environment, lifestyle, and dealing design, the demand for near and intermediate visual related tasks have expanded drastically consisting of work on the computer and related gazettes. There's a lot of strain on our external eye muscles which results in eye fatigue. An imbalance between the sensory-motor integrative functions causes non-strabismic accommodative and/or binocular vision anomalies. So, any anomaly in the visual system will thus have an impact on cognitive growth and performance. University students require time-consuming close work, long-term computer activities, and precise attention and fixation. Excessive close work causes non strabismic binocular vision anomalies, which has a direct influence on students' academic performance.[13–16] The study was done to find out how common non-strabismic binocular vision dysfunctions are among university students in north India. Despite the fact that numerous researchs have concentrated on assessing on ocular discomfort,[18,19] there haven't been many comprehensive research that investigate the prevalence and various types of binocular abnormalities among university students.

2. Materials and Methods

A cross-sectional study involving university students has been carried out between October 2017 and February 2020. Students were invited to the university eye clinic to take part in the study. A detailed information about the study was provided to all the students attending the clinic and all students provided their signed and informed consent.

2.1. Phase I: Vision screening and eye examination

A thorough medical and ocular history was obtained from 180 patients, including previous ocular and medical history, as well as family history. The chief complaints by the individuals were also recorded. comprehensive eye checkup that includes measuring visual acuity using Snellen's chart for both near and distance, objective and subjective refraction (static retinoscopy and subjective acceptance), Ocular motility using the Broad H test, Pupillary assessment and slit-lamp examination was performed. The inclusion criteria for the study were applied to those initial data and consisted of having best-corrected acuity (BCVA) 6/6, N6 both monocularly and binocularly for distance and near. Those having (BCVA) 6/6, N6 for both distant and near vision, and free of strabismus, amblyopia, any ocular or systemic diseases, past squint surgery, or head/eye/head injuries were advanced to the next stage.

2.2. Phase II: binocular vision screening protocol

Binocular vision Screening Protocol includes cover test, stereo acuity test using Titmus fly, and worth four dot test for supression. The subjects with constant or intermittent strabismus as which were detected using the cover test, Stereo acuity result in more than 40 arc seconds (Titmus fly test), suppression under Worth four dot test, were excluded from our study and were referred for further management, and the rest who passed, were included. But, it didn't qualify the subject to possess normal BV, until they clear the comprehensive Binocular vision and accommodative assessment.

2.3. Detailed binocular vision and accommodation assessment

Phobia measurement at distance and near using the cover test, the loose prism of increasing power has been used to measure the quantity of phoria. Near point of convergence was assessed by with an accommodative target of 6/9 reduced Snellen letters is held ahead of the subject at a distance of 45cm, and second, a penlight shine at 50cm with a red filter ahead of the right eye. The break and recovery values were measured and therefore the average of the three measurements was recorded. AC/A ratio was calculated using the heterophoria method: AC/A = IPD + FD* (NP-FP) where IPD in centimeters, near fixation distance (FD) in meters, and near and far Phoria (NP and FP) values in prism diopters, where esodeviation is marked as plus and exodeviation as minus, Inter-pupillary distance (IPD) was measured using the Pupillometer. Fusional vergence were assessed by employing a prism bar for both near and far, the Negative fusional vergence was measured first with prism BI, followed by Positive fusional vergence with prism BO. A vertical row of letters of 6/9 Snellen's equivalent was used as a target and blurred, break and recovery points were noted. Vergence facility has been measured with a 12 base-out/ 3 base-in prisms combination and therefore the number of cycles per minute (CPM) was noted down. The near point of accommodation was measured by the accommodative target held at 40 cm and brought closer until the subject reported sustained blur in both monocular and binocular conditions. The amplitude of accommodation was measured by converting it to a dioptric equivalent. The Monocular estimation method (MEM) retinoscopy was performed on the right eye of all the subjects by neutralizing the horizontal meridian. The monocular accommodative facility was assessed followed by the binocular accommodative

facility with target N8 size held at 40 cm, using ±2.00 DS lenses, the total number of words read in one minute was noted down.

180 University students between age group 17-35 years attending Sushant vision care center (SVCC) underwent phase I clinical trial (Vision screening and eye examination) and phase II clinical trial (binocular vision Screening Protocol) along side detailed binocular vision and accommodation assessment. (Figure 1)

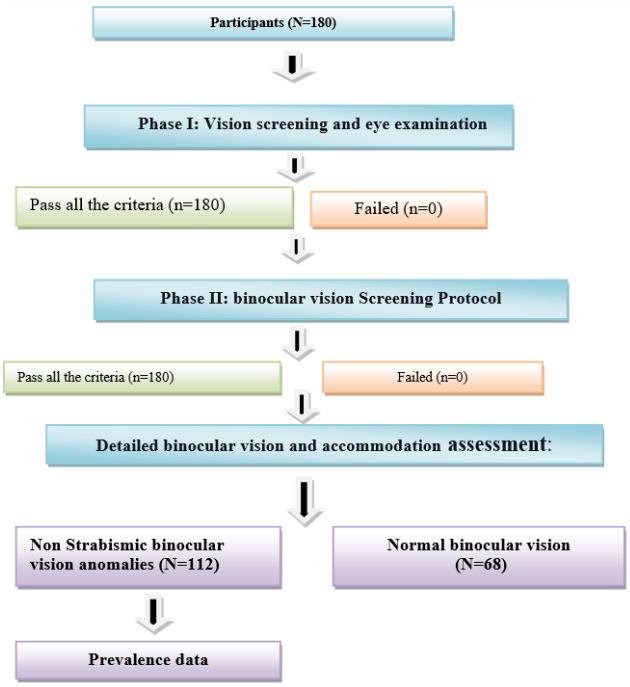

Figure 1: Flow chart of methodology

The cut-off criteria for diagnosis of Non strabismic binocular vision dysfunctions was adopted from report 1 of BAND (Binocular Vision Anomalies and Normative Data), Hussaindeen, Jameel Rizwana, et al.[20] (2017) for the Indian population.

3. Results

180 Students of Ansal erstwhile Sushant University attending Sushant vision care center (SVCC) between 17 -35 years of age were screened and included in the study. Out of 180, 102 (56.6%) were female and 78(43.3%) were male. The mean (SD) age of the sample was found to be 22.8±2.3 years (Mean±SD). Prevalence of Non strabismic binocular vision anomalies among University students was found to be 62.2% (n=112), and therefore the remaining 37.7% (n=68) were having normal binocular vision. Out of 180 students, 37.2% (n= 67) had binocular dysfunctions and 45 (25%) had accommodative dysfunctions. The most prevalent non-strabismic binocular vision disorders were Convergence Insufficiency (37.2%) followed by Accommodative Insufficiency (12.2%), Accommodative Infacility (7.2%), and Accommodative excess (5.5%) (Table 1).

Out of 180 students 37.7% (n=68) were free of binocular vision Anomalies. Normative value for various binocular vision parameters are shown in Table 2. Various parameters of binocular vision (Mean±SD) among different diagnostic groups shown in Table 3.

Table 1: Prevalence of non strabismic binocular vision anomalies

Dysfunction	Patient Number	Percentage (%)
Normal Binocular vision	68	37.7%
Overall NSBVA	112	62.2%
Convergence disorder(Convergence Insufficiency	67	37.2%
Accommodative Disorder	45	25%
Accommodative Insufficiency	22	12.2%
Accommodative Infacility	13	7.2%
Accommodative excess	10	5.5%

3.1. Near point of convergence (NPC) with accommodative target and penlight with red glass

The mean value for NPC with accommodative target and penlight with red glass was 6.6±2/8.6±3.3and 10±2.5/13.3±4.3 (break/recovery) respectively, showing stastistical significant between two different method ($p<0.05$) (Table 5).

3.2. Range of ocular symptom

Ocular symptoms were presented in 89 (49%) students and remaining 91(51%) were asymptomatic. The most commonly found ocular symptom were eyestrain (18%), headache (34%), watering (5%) and, combination of all (43%). Among symptomatic students, 66 students (36.6%) were diagnosed to have non strabismic binocular vision anomalies and 23 (12.7%) were with normal binocular vision (Table 4).

4. Discussion

The findings from the study suggest that a significant number of university students experience non-strabismic accommodative and vergence dysfunctions. Multiple studies on the prevalence of accommodative and vergence dysfunctions have been conducted using a variety of diagnostic criteria, demographic characteristics, and study areas. The present study was performed among 180 University students of North India. In the study, we observed that the proportion of females (56.6%) was greater than that of males (43.3%). It differs from a study conducted by Magdalene, Damaris, et al.[21] (2017) which

Table 2: Various binocular vision parameters (Mean±SD) among normal Binocularvision

Parameters		Normativedata (Mean ± SD)
MEM	OD	0.50±0.50
Phoria	Near	-1.34±2.7
	distance	-0.1±0.57
NPC with accommodative target	Break	6.5±1.8
	Recovery	8.3 ±2.9
NPC with Red glasses	Break	10±2.4
	Recovery	13±3.8
NPA	Monocularly	8.9 ±2.5
	Binocularly	8.5±1.79
Interpapillary distance (IPD) mm		59.7±3.7
AOA	Monocularly	11.6 ±2.7
	Binocularly	11.7 ±2.8
AC/A		5.4±1:1
NRA		+3.24±0.8
PRA		-3.85±2.1
PFV distance	Blur	12.3±11.1
	Break	22.5±9.7
	Recovery	17±7.7
PFV near	blur	13.4±11
	Break	25.6±10
	recovery	17.6±7.3
NFV Distance	Blur	3.8±8.6
	break	12.38±7.5
	Recovery	9.5±6
NFV near	Blur	11±9.8
	Break	19.6±8.7
	recovery	14.3±7
MAF	OD	13.5 ±3.4
BF		13.5±3.4
VF		13.3±3.5

Table 3: Various binocular vision parameters (Mean±SD) among different diagnostic groups

Parameters		Mean ±SD in various diagnosis groups			
		CI	AI	AIF	AE
MEM	OD	0.62±0.9	0.80±0.7	0.7±0.6	-0.8±0.8
Phoria	Near	Exo 5.1±4D	Exo 3.7±4.1 D	Exo 2.5±4.3 D	Eso1.7±4.7 D
NPC(pencil push up)	Break	12.3 ± 6	11.9±6	9.4±3.6	7.4±2
	Recovery	15 ± 6	14± 6.8	12±4.7	8.40±2.2
NPC with Red glasses	Break	16.4±6.3	16.9±6.1	13.2±4.3	10±3.1
	Recovery	19.8±7	18.7±6.8	15.6±5	12.1±4
NPA	OD	12±5	15 ± 4.7	12.2 ± 4.2	8.3±2
	OU	12±5.4	14.5±4	11±3.6	8.3±2
AOA	OD	9 ± 2.5	7.6 ± 3.4	9.6 ± 3	12.5±3.3
	OU	9.3 ± 2.8	7.7±2.9	9.8 ±2.7	12.4±3.2
Ac/a		4.2 ± 1.5:1	5 ±1.3:1	5.3±1.4:1	5.9±1.7:1
NRA		+2.7 ± 0.8	+3 ± 1.7	+2.2±0.7	2.6±1
PRA		-4± 2	-2.7 ± 1.8	-2.3 ± 0.7	-4.8±1.2
PFV distance	Break	15.8 ±6	18.7 ±10	17.3 ± 6.7	26.6 ±6.8
	Recovery	11.8 ±5.5	11.4 ±5.8	13 ±6.8	22 ±8.4
MAF	OD	12.6 ±4	7.5 ±4.2	5.4 ±2.2	87.3±3.7
BAF		10.5 ±4.4	8±5.2	5.2 ±2.6	8.2±4
VF		11±4.3	10.6±4.3	9±2.8	13.8±5

Table 4: Percentage of ocular symptoms among Normal binocular vision and NSBVA

Ocular symptoms	With NSBVA	Without NSBVA
Students with Ocular symptoms	66(36.3%)	23(12.7%)
Students without Ocular symptoms	46(25.5%)	45(22.2%)
Total	112	68

Table 5: Showing statistical significant in near point of convergence between two different method

Near point of convergence		Wilcoxon Signed Ranks Test Sig. (2-tailed)
Break Point	Accommodative target Penlight with red & green glass	p=0.00 (<0.05)
Recovery Point	Accommodative target Penlight with red & green glass	p=0.00 (<0.05)

reported a higher male-to-female ratio. It's worth noting that there are limited prior studies that have examined the distribution of sexes in cases of non-strabismic accommodative and vergence dysfunctions. In our study, the prevalence of -strabismic binocular vision anomalies was found to be 62.2% (n=112), and thus the remaining 37.7% (n=68) were normal binocular vision. Specifically, 67 patients (37.2%) had binocular dysfunctions and 45 patients (25%) had Accommodative dysfunctions. The most prevalent non-strabismic binocular vision disorder was Convergence Insufficiency (37.2%) followed by accommodative Insufficiency (12.2%), accommodative Infacility (7.2%), and accommodative excess (5.5%). Our study results are fairly almost like the study conducted by Damaris, et al.[21] (2017) reported the prevalence of NSBVA was 69.35% (11–20 years), 67.35% (21–30 years), 50% (31–40 years) with convergence insufficiency is found to be most prevalent. Manish Dahal et al.[22] (2019) and Montes-Mico[23] (2001) reported prevalence of non-strabismic binocular vision anomalies as 55% and 56.2% respectively. Hoseini-Yazdi, Seyed Hosein, et al.[24] (2015), 261 patients who came to the optometric clinic's age range of < 35year, found 7.2% had accommodative dysfunction and 12.1% had binocular dysfunction with Convergence insufficiency and accommodative excess with 3.6% being most prevalent. The results of these studies were close to the present study since all these studies shared a close-range aged group with present studies. In contrast to the study conducted by Hussaindeen, Jameel Rizwana, et al[6] (2017), 936 children, school-going children between 7 -17 years reported non-strabismic binocular vision anomalies prevalence's were 36.2% and 25.1% between 7-12 and 13-17 years respectively with CI of 14.6% and 19.6% between 7-12years and 13-17years being most prevalent followed by accommodative infacility of 9.3% and 11.1% respectively. Jung Un Jang[9] (2015), examined 589 schoolchildren of aged range 8-13 years. They found 28.5% to the present with non-strabismic accommodative or vergence dysfunction. Prevalence of accommodative dysfunction and vergence dysfunction was 13.2% and 9% respectively. Convergence insufficiency with 10.3% was most prevalent followed by accommodative insufficiency with (5.3%), accommodative infacility (2.5%), convergence excess (1.9%), accommodative excess (1.2%). The present study result's are almost like those two studies despite different age groups, indicating Convergence insufficiency being most prevalent among non-strabismic binocular vision anomalies in both pediatric and non-pediatric age groups also. However, the prevalence of the present study is high due to variations in sample age criteria. The greater prevalence of convergence and binocular abnormalities might be explained by students' vocational demands, which need longer durations of close work, making them more prone to report signs of these dysfunctions. In contrast to the study conducted by Scheiman et al.[17] (1996),included 2023 participants between 6 months -18 years result, Convergence excess of 2.1% and 8.2% were most prevalent followed by Convergence insufficiency 1.8% and 5.3% between 6 months-5 years and 6years-11years respectively. They classified a patient as having accommodative insufficiency if, in addition to having a low amplitude of accommodation, they failed two or more of the following tests: PRA (positive relative accommodation), monocular accommodative facility, binocular accommodative facility, and MEM retinoscopy. Using these criteria, they discovered that 2% of the individuals in the whole sample showed accommodative insufficiency, whereas those with accommodative excess represented 1.8% of the whole patients studied. García-Muñoz, Ángel, et al.[4] (2015), examined a sample of 175 university students aged between 18 and 35 years. The diagnosis was based on classification made by Scheiman and wick. Thus, the prevalence of accommodative and/or binocular dysfunction was 13.15% with accommodative dysfunction (2.29%) and binocular dysfunction (8%). Thus, we observed a higher occurrence of patients with binocular dysfunctions in comparison to those with accommodative dysfunctions. Specifically, we found a greater prevalence of convergence insufficiency 3.43%, followed by accommodative excess/convergence excess

2.29%. It's coincides with the results obtained in the present study.

Hokoda, S. C. (1985),[25] conducted a study involving 119 patients, all under the age of 35, at a single optometric clinic over a duration of six months. However, the most common disorder was accommodative insufficiency, found in 11 subjects, five of whom had also a binocular dysfunction. The criteria used to diagnose accommodative insufficiency in that particular study included assessing the amplitude of accommodation and positive relative accommodation (PRA) results. Specifically, individuals were considered to have accommodative insufficiency if they exhibited an amplitude of accommodation at least 2 diopters below the minimum established by Hofstetter's formula (Borish, 1975) and a PRA value equal to or less than 1.50 diopters. The divergence in diagnostic criteria might explain why Hokoda[25](1985), reported a higher prevalence of accommodative insufficiency. In another study by Daum, KENT M.[26] (1983), it was found that 96 subjects, constituting 80% of the entire sample, exhibited accommodative insufficiencies. The diagnosis of accommodative insufficiency was solely determined by measuring the accommodative amplitude. A patient was classified as having accommodative insufficiency when their accommodative amplitude fell below the expected lower limit for their age. Considering the single criterion, certain conditions characterized by diminished accommodative amplitude could have been categorized differently if additional signs and factors had been considered. Moreover, the population utilized in study was preselected so that the data should not be considered exactly representative of the general population. Lara, Francisco, et al.[27] (2001), revealed that prevalent of binocular dysfunctions were the most common (12.9%), followed by accommodative dysfunctions (9.4%), coincides with the results obtained in our study. however, they found a higher prevalence of accommodative excess (6.4%) followed accommodative insufficiency (3.0%), convergence excess (4.5%), convergence insufficiency (0.8%). Porcar, Esteban, and Antonio Martinez-Palomera[8] (1997), conducted a study on 65 university students averaging around 22 years of age, 32.3% of whom proved to have accommodative and/or binocular disorders. Their study found a higher prevalence of accommodative excess (10.8%) than accommodative insufficiency (6.2%). Both studies have Just opposite results to what we've obtained in our study. Lara, Francisco, et al.[27] (2001), investigated a group of 265 symptomatic individuals aged between 10 and 35 years, all of whom had sequentially visited an optometric clinic. The sample was drawn from a clinical setting where the prevalence of symptomatic patients seeking solutions is higher compared to the general population. Furthermore, their study included data on children, although they did not provide specific information on the number of patients aged 18 years. Also, they used different diagnostic criteria for analyzing the results. Whereas the present study used the diagnostic criteria that are given by Hussaindeen, Jameel Rizwana, et al[20] for the Indian population. Porcar and Martinez-Palomera[8] (1997) used similar diagnostic criteria to Lara, Francisco et al.[27] (2001). Additionally, they excluded individuals with a considerable uncorrected refractive error. The particular criterion introduced a selection bias into the sample since uncorrected refractive errors might coexist with accommodative and binocular dysfunctions. Limitations of the current study encompass a relatively small sample size, inability to find association of NSBVA with working hours, and the inability to demonstrate the efficacy and outcome of vision therapy in strabismic accommodative and vergence dysfunctions patients due to the study short length.

5. Conclusion

To summarize, our results suggest that non-strabismic accommodative and vergence dysfunctions highly prevalent among University students with female being more affected. We have found high prevalence of vergence dysfunctions in comparison to accommodative dysfunctions, with Convergence Insufficiency (37.2%) being most prevalent followed by accommodative Insufficiency (12.2%), accommodative Infacility (7.2%), and accommodative excess (5.5%). Many of students with NSBVA show ocular symptoms 66 (36.3%), but some with 46(25.5%) still not showing any ocular symptoms. It may lead to so the delayed in diagnosis of such anomaly. Screening of University students can help in timely diagnosis and treatment of NSBVA. For university students, conducting comprehensive eye examination that assesses accommodative and binocular functions alongside refraction is vital. It will ensure early detection of potential disorders. If needed, treatment like lenses, prisms, and vision therapy can enhance vision and performance.

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None.

7. Conflict of Interest

None.

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Author biography

Tsering Lamu Shongmu, Assistant Professor https://orcid.org/0000-0002-7017-7173

Zeeshan Akhtar, Assistant Professor

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