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Research Article

Non Strabismic Binocular Vision Disorders Among VDU Users of Bangalore, Karnataka

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Abstract

Purpose: To evaluate major symptoms and non strabismic binocular vision disorders among VDU users in Bangalore.

Methodology: Among 90 VDU users, assessment included visual acuity, retinoscopy, convergence, accommodation, fusional vergence, vergence facility and accommodation facility. Subjects' symptoms were recorded in the COVD questionnaire (QOL 19).

Results: Mean age of subjects was 25.8 ± 3 years. Ocular changes were reported in 85% of the total subjects. The common non strabismic binocular vision anomaly was Convergence insufficiency with a secondary accommodative excess. The most common symptoms ($p < 0.001$) were headache with near work and trouble keeping attention on reading.

Conclusion: Convergence insufficiency associated with a secondary accommodative excess and headache with near work were the most common abnormalities and symptom reported. Non strabismic binocular vision disorders were correlated with symptoms assessed through COVD questionnaire (QOL 19).

Keywords: VDU; Non Strabismic Binocular Vision Disorders

Abbreviations

NSBVD: Non Strabismic Binocular Vision Disorders; VDU: Visual Display Units; COVD-QOL-19: College of Optometrists in Vision Development Quality Of Life - 19 Questionnaire; NRA: Negative Relative Accommodation; PRA: Positive Relative Accommodation; NPC: Near Point of Convergence; NPA: Near point of Accommodation; NFV: Negative Fusional Vergence; PFV: Positive Fusional Vergence; AC/A: Ratio of Accommodative Convergence to Accommodation; cpm: Cycles Per Minute; BI: Base In; BO: Base Out; D: Distance; N: Near.

Introduction

In the current scenario VDU has become a main media and has huge role in our society. It plays a very important role in every way of life. As societies industrialize and the technological revolution continues, there has been a significant increase in the number of Visual display units. While these sources have made our life richer, safer and easier, they have been accompanied by concerns about health risks.

Vision and eye related problem at computer display are very common. Computer vision syndrome (CVS) is defined by American Optometry Association as the complex of eye and vision problems related to near work which are experienced during or related to computer use. Computer use is such a high visually demanding task, vision problems and symptoms have become very common in today's workplace [2].

Research specify that 90% of people those who use VDU for greater than 2 h in a day experience vision-related symptoms. Those who spend greater than 4h per day working on VDU tasks experience much higher experience, severity, and duration of VDU related symptoms. These symptoms may be related either to ergonomic problems of workstation equipment and setup, vision problems such as refractive error, accommodation to the computer screen, convergence fatigue, or visual skills, ocular physiology, or spectacle lens design problems [3].

Surveys show that nearly 15% of patients seeking general eye care schedule their visual examination as a result of VDU related visual complaints [19]. This is not surprising, as recently as the late 1980s, about 30% of the workforce used computers and now that percentage is well above 70%.

According to a workshop conducted by WHO International EMF (Electromagnetic field) project as part of the scientific review process to determine biological and health effects from exposure to EMF, they have reported that the sensitivity reactions include a wide range of non-specific symptoms, which afflicted individuals attribute. The symptoms most commonly reported include dermatological symptoms (redness, tingling and burning sensations) as well as neurasthenic symptoms like headache, fatigue, stress, sleep disturbances and vegetative symptoms (fatigue, tiredness, concentration difficulties, dizziness, nausea, heart palpitation and digestive disturbances). Some individuals are so severely affected that they cease work and change their entire lifestyle, while others report mild symptoms and react by avoiding the fields as best they can. Among all the health risks associated with exposure of EMF, eye symptoms have found to be more. A study done by Toomingas., *et al*. on the risk factors, incidence and persistence of eye symptoms among professionally active computer users is high and related to both individual and work related factors.

Many individuals who work at a computer video display terminal (VDT) report a high level of job related complaints and symptoms, including ocular discomfort, muscular strain and stress. Eye problems such as eyestrain associated with frontal headache, tired eyes, blurred vision and double vision etc. are some of the common symptoms that are reported in eye clinic these days. Visual discomfort and related symptoms occurring in VDU users must be recognized as a growing health problem. Also, the problem is not limited to adults. Many children use VDU for educational and recreational purposes. The way that children use the VDU may make them even more susceptible to development of VDU related visual symptoms. Children often continue performing an enjoyable task, such as video games, without breaks, until near exhaustion. Such prolonged activity can increase eye focusing problems and eye irritation.

Computer users often assume uncomfortable positions in order to properly view the screen. It is a repetitive strain disorder that appears to be growing rapidly, with studies world internet user and population statistic estimating that 45% of Asian workers using computers for more than 3 hours per day experience it in some form.

Blurring of vision, either during near work or when looking into the distance object after long duration of using computer symptom are more commonly associated with CVS. This may result from an inaccurate accommodative response during the computer task or a failure to relax the accommodative response fully following the near-vision demands. Patients' symptoms commonly relate to near-vision work, and ill-suited responses, whether under or over-accommodation relative to the object of regard are a common cause of asthenopia. Indeed, amongst a group of symptomatic computer users, accommodative infacility was the most common oculomotor anomaly found.

Symptoms associated with VDU use can largely be categorized into four primary areas-refractive, binocular vision, ocular and systemic health. Symptoms resulting from each of these can be resolved with proper care. Use of VDUs is on risk in Bangalore (IT Hub), Karnataka owing to growing trend towards office computerization. So, this study is aimed to review the factors relating to eye and visual problems associated with VDU use and find out their associations among VDU users in Bangalore, Karnataka.

Aim of the Study

To evaluate major symptoms and non strabismic binocular vision disorders among VDU users in Bangalore

Objectives

- To assess non strabismic binocular vision disorders in heavy users of VDU
- To assess non strabismic binocular vision disorders in moderate users of VDU
- To assess non strabismic binocular vision disorders in minimum users of VDU

Note

- Heavy users: people who use VDU more than 8hours (over a period of 2months)
- Moderate users: people who use VDU between 4 to 8 hours (over a period of 2months)
- Minimum users: people who use VDU less than 4 hours (over a period of 2months)

Materials and Methods

- **Study population:** VDU users of Bangalore
- **Study design:** Cross sectional study
- **Study setting:** Multiple centres at Bangalore
- **Study duration:** December 2014- January 2016

Sample size calculation:

$n = 2(Z_{1-\alpha/2}+Z_{1-\beta/2})^2\sigma^2/d^2$

$= 2(1.96+0.84)(2.648)^2/(1.122)^2$

$= 2(7.84)(7.02)/1.259$

$= 110.074/1.259$

$n = 87$

Where, for 95% Confidence Interval $Z_{1-\alpha/2} = 1.96$

Keeping 80 as the Power, $Z_{1-\beta/2} = 0.84$

σ (standard deviation) and d (mean of difference)

These data have been taken from the previous similar study, so minimum of 87 VDU users were expected to have non strabismic binocular vision anomalies out of all users from 15 to 35 years old. So the final sample size taken for the study was 90.

Sampling technique

Random sampling method.

Inclusion criteria

- VDU users aged between 15 to 35 years in both gender
- Best corrected visual acuity equal or better than 20/20 monocularly

Exclusion criteria

- Subjects presenting with strabismus/amblyopia
- Presence of systemic or ocular pathology which affects vision

Materials

- COVD-QOL 19 questions questionnaire to evaluate symptom score.

COVD questionnaire

The Quality of Life Outcomes Assessment Committee devised a questionnaire to administer to patients before, and after the completion of vision therapy. This questionnaire addresses symptoms associated with vision anomalies from four broad categories of quality of life: somatic, physical/occupational, social, and psychological. The symptom scores were ranked on intensity rating as 0 = never, 1 = seldom, 2 = occasional, 3 = frequently and 4 = always. The subjects were asked to state the occurrence of symptom and specify the hours at which they did VDT work.

A total score of 20 or more than 20 is considered as having binocular vision disorders.

Assessment

For screening vision, we have used LogMAR visual acuity chart both for distance and near, objective refraction was done by retinoscope (Heine), anterior examination with slit lamp and fundus evaluation by direct ophthalmoscope.

In binocular vision assessment, stereopsis was checked with Randot stereogram, WFDT was examined at all distances (to measure suppression scotoma, if present) with WFDT torch, cover test was done at distance and near with hand held occluder and measured with prism bar if there is any deviation. Maddox rod test (subjective) was done to measure phoria. Near point of convergence was measured with accommodative target (N8 letter size) and with non-accommodative target (red filter and point source light) Near point of accommodation was again measured with N8 letter size. MEM (Monocular estimation method) was examined with Wellch Allyn Retinoscope. Fusional vergence was checked both at distance and near with horizontal prism bar. Vergence facility was checked with vergence flipper (3 prism BI and 12 prism BO) and finally accommodative facility was checked with a rock card and flipper of +/-2.00Ds.

Methodology

Subjects were selected from multiple centers of Bangalore from December 2014 to January 2016. It included 30 students (bachelor level), 20 (22.2%) computer operators (software engineers, web designers and data analysts) and 10 (11.1%) office workers (clerical staffs, administrative officers and receptionist). The purpose of the study was clearly explained and informed consent was taken from each subjects. Subjects were enrolled in the study on the basis of their working hours on VDU (like desktop, laptop, tablets and mobiles).

For the study, we have divided the VDU users into three different groups according to their working hours with it. They are as the following.

Group	Category	Working hours	Subjects	No of males	No of females
1	Heavy user	>8HOURS	30	15	15
2	Moderate user	4-8HOURS	30	15	15
3	Minimum user	<4HOURS	30	15	15

Table a

All subjects had undergone comprehensive ocular examination including detailed history, BCVA, anterior and posterior examination. Eyes that fulfil the inclusion criteria are selected for binocular vision assessment.

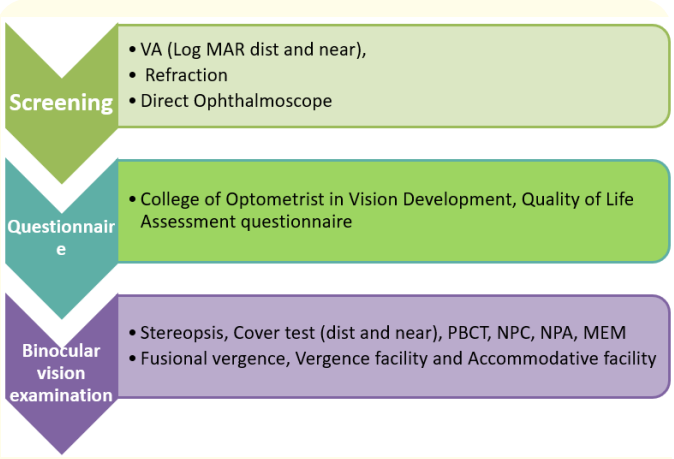

Figure a

The assessment involved structured questionnaire concerning subjective symptoms and determination of the optometric routine status. Medical history was recorded to exclude any systemic disease, ocular disease or use of medication. The questionnaire was collected and the eye examination was conducted the same day.

Screening

Visual acuity: Monocular visual acuity was measured and recorded with Log MAR chart at distance under normal lighting condition. Near visual acuity was measured at 35-40 cm.

Binocular vision assessment

Refraction

Static and subjective refraction were carried out in every subject. A change or presence in spherical equivalent refractive error equal to or greater than ± 0.50 D was considered significant. Dynamic retinoscopy was carried out at 35-40 cm by monocular estimation method. Normal lag of accommodation was considered as + 0.75 D.

Cover test

Ocular alignment was assessed by means of cover test at six meter distance and at 40 cm distance. No movement on cover test was considered as orthophoria. Exophoria was considered significant

when outward latent deviation exceeded four prism diopters at distance and six prism diopters at near. Esophoria was considered significant when inward deviation exceeded two prism diopters at distance and two prism diopters at near.

Positive fusional vergence

Vergence amplitude was measured at 40 cm and 6 m with the help of horizontal prism bars placing base out before subject's one eye and increasing power of prism gradually unless subject noticed first blur, break and recovery. Morgan's norm was considered as normal score for near (17/21/11) and distance (9/19/10) fusional vergence.

Near point of convergence

Near point of convergence was measured with an accommodative target at primary gaze by moving the letter along the scale towards the eye. Convergence of less than 7 cm was considered normal and ≥ 7 cm was defective.

Amplitude of accommodation

Amplitude of accommodation was measured again with a letter target of N8 size. The print was then moved towards the subject until the letters became completely blurred. Normal value of amplitude of accommodation was calculated by the Hoffstters formula [Amplitude of accommodation = 18.5-(Age/3)].

Accommodative facility

Accommodative facility was measured with ± 2.0 D binocular flipper lens at 40 cm distance viewing target letter size equivalent to N8. The diagnostic criterion was set at 10 cycles per minute binocularly. Below this score was considered abnormal.

Results and Discussion

A total of 90 subjects were enrolled for the study out of which 46 subjects (51%) were females and 44 subjects (48.9%) were males. The mean age of the subjects was 26.8 +/- 1.39 years

- **Statistical software:** The Statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and R environment ver.2.11.1 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.
- **Statistical Methods:** Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance.

The following assumptions on data is made

Assumptions: 1. Dependent variables should be normally distributed, 2.Samples drawn from the population should be random, Cases of the samples should be independent.

Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups.

Data analysis

Minimum users

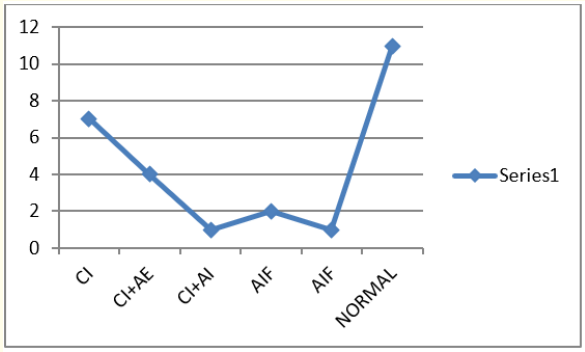

Figure 1: Minimum users.

In minimum users it is seen that most of them were under normal binocular vision and among NSBVD, Convergence insufficiency is seen more in minimum users (26.7%). Secondly, convergence insufficiency with a secondary accommodative excess (16.7%), showed higher, thirdly accommodative Infacility (6.7%) and lastly convergence insufficiency with accommodative infacility. Least number of accommodative insufficiency and convergence excess is reported from minimum users.

Moderate users

Convergence insufficiency associated with a secondary accommodative excess is seen more in VDU users, especially among moderate users (26.7%). Secondly, accommodative excess (23.3%),

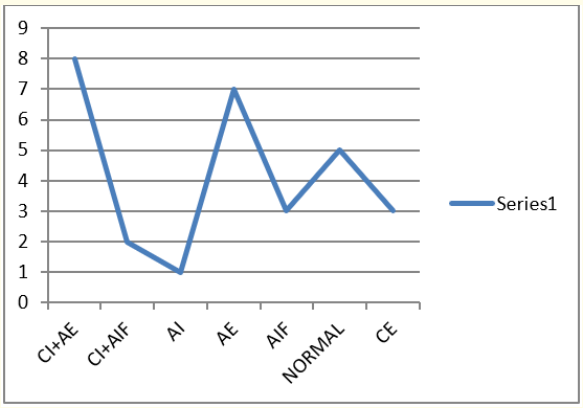

Figure 2: Moderate users.

thirdly accommodative Infacility (13.3%) among NSBVD and convergence insufficiency with accommodative infacilty (6.7%). Also, here least symptoms are noted from accommodative insufficiency (3.3%).

Heavy users

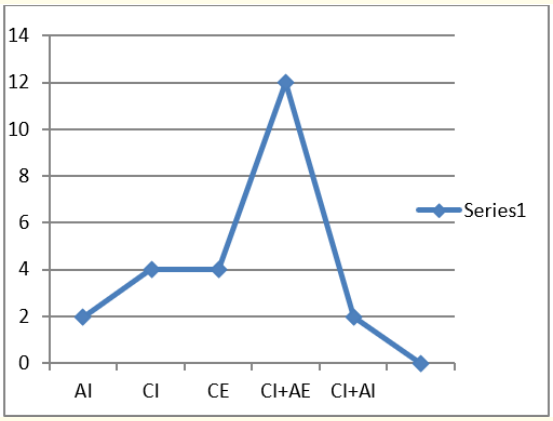

Figure 3: Heavy users.

In heavy users, convergence insufficiency with a secondary accommodative excess (40%) Secondly, accommodative excess (13.3%), thirdly convergence insufficiency with accommodative Infacility (10%). Least number was reported from accommodative insufficiency (6.7%).

Symptomatic subjects

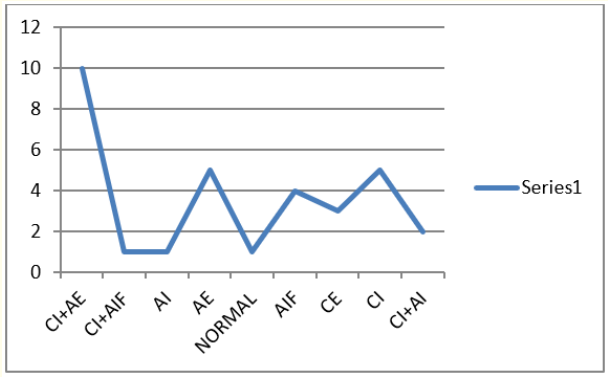

Figure 4: Symptomic subjects.

According to COVD questionnaire scoring, in our observation we have noticed that the subjects with Convergence insufficiency with a secondary accommodative excess have experienced symptoms more than the other NSBVD. Secondly, Accommodative excess reported more symptoms; next symptoms were on Convergence Insufficiency, Accommodative Excess, Accommodative Infacility, Convergence excess, Convergence Insufficiency with accommodative insufficiency and least was reported on Accommodative Insufficiency.

Asymptomatic subjects

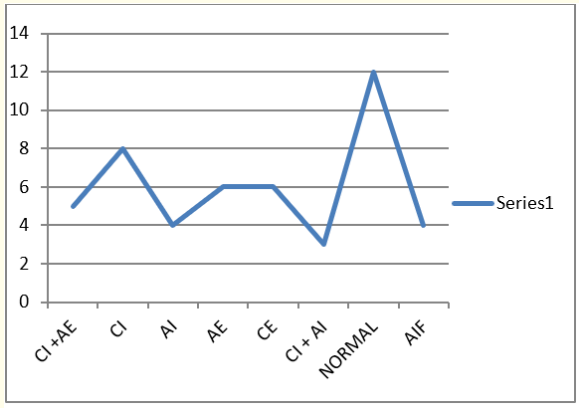

Figure 5: Asymptomatic.

Also, subjects with normal binocular vision are found to be asymptomatic through the COVD questionnaire. So, our clinical findings are significantly correlated with the symptoms reported by the VDU users.

Statistical analysis

Distribution of gender among three groups

Among the gender distribution in three groups, P value is 0.089, chi squre = 0.36, which shows that gender is not statistically significant here.

Distribution of age among three groups

Among the age distribution in groups, mean age across the three groups showed a statistical significance. (P = 0.0001, F = 14.51 using ANOVA) The mean age in minimum users was 29.07, 23.20 in moderate users and 28.13 in heavy users.

Group	Mean Age	Std. Deviation	P value
VDT 6-8 HOURS	23.20	4.498	0.0001*
VDT <4 HOURS	29.07	5.065	F=14.51[a]
VDT>8 hrs	28.13	3.972	

Table 2: Distribution of age among three group.

*statistically significant at 5% level of significance

a ANOVA

Distribution of symptom score among three groups

Also, among the symptom score in groups, mean age across the three groups showed a statistical significance. (P=0.040, F=3.34 using ANOVA) The mean symptom score for minimum users was 12.20, 17.10 in moderate users and 18.17 in heavy users.

Group	SYM SCORE Mean	Std. Deviation	P value
VDT 6-8 HOURS	17.10	8.531	0.040*
VDT <4 HOURS	12.20	8.331	F=3.34[a]
VDT>8 hrs	18.17	11.429	

Table 3: Distribution of SYM score among three group.

*statistically significant at 5% level of significance.

a ANOVA.

Comparison between each group by POST HOC test

By comparing each group with a dependent variable as age in Post HOC test, VDU <4hours with VDU 6-8hours showed a mean difference of -5.867 which is statistically significant with a P value of 0.0001.

Dependent Variable	Group	Group	Mean Difference	95% Confidence Interval		P value
				Lower Bound	Upper Bound	
AGE	VDT 6-8 HOURS	VDT <4 HOURS	-5.867*	-8.19	-3.54	0.0001*
		VDT>8 hrs	-4.933*	-7.26	-2.61	0.0001*
	VDT <4 HOURS	VDT 6-8 HOURS	5.867*	3.54	8.19	0.0001*
		VDT>8 hrs	.933	-1.39	3.26	0.43
	VDT>8 hrs	VDT 6-8 HOURS	4.933*	2.61	7.26	0.0001*
		VDT <4 HOURS	-.933	-3.26	1.39	0.43
SYM SCORE	VDT 6-8 HOURS	VDT <4 HOURS	4.900*	.01	9.79	0.050
		VDT>8 hrs	-1.067	-5.96	3.83	0.666
	VDT <4 HOURS	VDT 6-8 HOURS	-4.900*	-9.79	.00	0.050
		VDT>8 hrs	-5.967*	-10.86	-1.07	0.017*
	VDT>8 hrs	VDT 6-8 HOURS	1.067	-3.83	5.96	0.666
		VDT <4 HOURS	5.967*	1.07	10.86	0.017*

Table 4: Comparison between each group by post hoc test.

*statistically significant at 5% level of significance.

VDU 4-8 hours with VDU >8hours showed a mean difference of 4.933 which is also statistically significant with a P value 0.0001. When comparing VDU<4hours with VDU >8 hours showed a mean difference of 0.933 and the P value is 0.43.

Statistical significance is seen in VDU 4-8hours with VDU <4hours (P value=0.0001) and with VDU 4-8hours with VDU >8hours (P value=0.0001). But statistically high significance is seen in VDU 4-8hours with VDU <4hours (Mean difference= -5.867).

While comparing symptom score as the dependent variable among three groups, VDU 4-8hours with VDU <4hours showed a mean difference of 4.900 with a P value of 0.050.

VDU 4-8hours with VDU >8hours showed a mean difference of -1.067 (P value=0.666) and in VDU <4hours with VDU >8hours had a mean difference of -5.967 with a P value of 0.017 which is statistically significant.

Statistical analysis on symptoms

Among the symptoms, headaches with near work is moderately significant (P <0.013) and trouble keeping attention on reading shows suggestive significance (P <0.072) in all the three groups.

COVD- QOL Checklist Questionnaire	Group	Never	Seldom	Occasional	Frequently	Always	P value
Headaches with near work	<4	1(7.7%)	2(15.4%)	6(46.2%)	4(30.8%)	0(0%)	0.013*
	4-6	2(15.4%)	1(7.7%)	5(38.5%)	3(23.1%)	2(15.4%)	
	>8	0(0%)	1(7.7%)	0(0%)	10(76.9%)	2(15.4%)	
Words run together reading	<4	11(84.6%)	0(0%)	2(15.4%)	0(0%)	0(0%)	0.367
	4-6	7(53.8%)	2(15.4%)	2(15.4%)	2(15.4%)	0(0%)	
	>8	6(46.2%)	3(23.1%)	2(15.4%)	1(7.7%)	1(7.7%)	
Burning, itchy, watery eyes	<4	4(30.8%)	1(7.7%)	3(23.1%)	5(38.5%)	0(0%)	0.720
	4-6	2(15.4%)	1(7.7%)	4(30.8%)	4(30.8%)	2(15.4%)	
	>8	1(7.7%)	2(15.4%)	4(30.8%)	6(46.2%)	0(0%)	
Skips/repeats lines reading	<4	7(53.8%)	3(23.1%)	2(15.4%)	1(7.7%)	0(0%)	0.769
	4-6	7(53.8%)	1(7.7%)	2(15.4%)	3(23.1%)	0(0%)	
	>8	5(38.5%)	2(15.4%)	4(30.8%)	1(7.7%)	1(7.7%)	
Tilts head/ closes one eye when reading	<4	8(61.5%)	1(7.7%)	1(7.7%)	2(15.4%)	1(7.7%)	0.971
	4-6	10(76.9%)	1(7.7%)	1(7.7%)	1(7.7%)	0(0%)	
	>8	8(61.5%)	1(7.7%)	2(15.4%)	2(15.4%)	0(0%)	
Difficulty copying from chalkboard	<4	10(76.9%)	2(15.4%)	1(7.7%)	0(0%)	0(0%)	0.480
	4-6	10(76.9%)	1(7.7%)	2(15.4%)	0(0%)	0(0%)	
	>8	8(61.5%)	1(7.7%)	1(7.7%)	3(23.1%)	0(0%)	
Avoids near work/ reading	<4	7(53.8%)	2(15.4%)	4(30.8%)	0(0%)	0(0%)	0.582
	4-6	6(46.2%)	1(7.7%)	5(38.5%)	1(7.7%)	0(0%)	
	>8	5(38.5%)	2(15.4%)	2(15.4%)	3(23.1%)	1(7.7%)	
Omits small words when reading	<4	11(84.6%)	2(15.4%)	0(0%)	0(0%)	0(0%)	0.406
	4-6	7(53.8%)	3(23.1%)	3(23.1%)	0(0%)	0(0%)	
	>8	9(69.2%)	2(15.4%)	2(15.4%)	0(0%)	0(0%)	
Writes up/ down hill	<4	10(76.9%)	1(7.7%)	2(15.4%)	0(0%)	0(0%)	0.804
	4-6	11(84.6%)	0(0%)	1(7.7%)	0(0%)	1(7.7%)	
	>8	9(69.2%)	2(15.4%)	2(15.4%)	0(0%)	0(0%)	

Misaligns digits/ columns of numbers	<4	10(76.9%)	2(15.4%)	1(7.7%)	0(0%)	0(0%)	1.000
	4-6	11(84.6%)	2(15.4%)	0(0%)	0(0%)	0(0%)	
	>8	11(84.6%)	1(7.7%)	1(7.7%)	0(0%)	0(0%)	
Reading comprehension down	<4	11(84.6%)	1(7.7%)	1(7.7%)	0(0%)	0(0%)	0.880
	4-6	11(84.6%)	1(7.7%)	1(7.7%)	0(0%)	0(0%)	
	>8	9(69.2%)	1(7.7%)	1(7.7%)	2(15.4%)	0(0%)	
Holds reading too close	<4	9(69.2%)	1(7.7%)	1(7.7%)	1(7.7%)	1(7.7%)	0.792
	4-6	6(46.2%)	2(15.4%)	4(30.8%)	1(7.7%)	0(0%)	
	>8	5(38.5%)	2(15.4%)	3(23.1%)	2(15.4%)	1(7.7%)	
Trouble keeping attention on reading	<4	2(15.4%)	1(7.7%)	6(46.2%)	3(23.1%)	1(7.7%)	0.072+
	4-6	2(15.4%)	1(7.7%)	4(30.8%)	5(38.5%)	1(7.7%)	
	>8	6(46.2%)	4(30.8%)	0(0%)	2(15.4%)	1(7.7%)	
Difficulty completing assignments on time	<4	10(76.9%)	0(0%)	2(15.4%)	0(0%)	1(7.7%)	0.181
	4-6	6(46.2%)	1(7.7%)	2(15.4%)	2(15.4%)	2(15.4%)	
	>8	7(53.8%)	4(30.8%)	2(15.4%)	0(0%)	0(0%)	
Always says 'I can't' before trying	<4	7(53.8%)	1(7.7%)	2(15.4%)	3(23.1%)	0(0%)	0.631
	4-6	7(53.8%)	3(23.1%)	3(23.1%)	0(0%)	0(0%)	
	>8	8(61.5%)	1(7.7%)	3(23.1%)	1(7.7%)	0(0%)	
Clumsy, knocks things over	<4	7(53.8%)	1(7.7%)	3(23.1%)	0(0%)	2(15.4%)	0.639
	4-6	7(53.8%)	2(15.4%)	2(15.4%)	2(15.4%)	0(0%)	
	>8	9(69.2%)	2(15.4%)	1(7.7%)	1(7.7%)	0(0%)	

			Group			Total	P value
			VDT 6-8 HOURS	VDT <4 HOURS	VDT >8 HOURS		
Diag	AE	Count	7	0	4	11	0.0001*
		%	23.3%	.0%	13.3%	12.2%	
	AI	Count	1	2	2	5	Fisher's Exact value=39.06
		%	3.3%	6.7%	6.7%	5.6%	
	AIF	Count	4	4	0	8	
		%	13.3%	13.3%	.0%	8.9%	
	CE	Count	3	2	4	9	
		%	10.0%	6.7%	13.3%	10.0%	
	CI	Count	0	8	5	13	
		%	.0%	26.7%	16.7%	14.4%	
	CI + AE	Count	8	5	12	25	
		%	26.7%	16.7%	40.0%	27.8%	
	CI +AI	Count	0	1	3	4	
		%	.0%	3.3%	10.0%	4.4%	
	CI +AIF	Count	2	0	0	2	
		%	6.7%	.0%	.0%	2.2%	
	NORMAL	Count	5	8	0	13	
		%	16.7%	26.7%	.0%	14.4%	
Total		Count	30	30	30	90	

Table 6: Diagnosis in all groups are clinically and statistically significant (P=0.0001, F=39.06).

Among the 90 subjects, the number of people diagnosed with normal binocular vision was 13 in all the three groups. In that minimum users had 8 subjects (26.7%), moderate users had 5 (16.7%) and there was none diagnosed with normal binocular vision from heavy users.

From NSBVD, Vergence dysfunction is found to be higher in our study (36.6%).

The diagnosis in all groups are clinically and statistically significant (P = 0.0001, F = 39.06)

Among the Accommodative anomalies, Accommodative excess is seen more (12.2%). Whereas among vergence anomalies convergence insufficiency is found more (14.4%). Results indicate a positive relation between vergence effort and visual symptoms. Also, that prolonged near work leads to decreased vergence accuracy.

Summary

- Among all the diagnosis in our study, Convergence insufficiency with a secondary accommodative excess is clinically and statistically significant. This plays a major role in visual interruption compared to other daignosis
- In symptoms, headache with near work has shown moderately significance in all three groups with a P value of 0.013. Similarly, trouble keeping attention on reading also has shown statistically suggestive significance with a P value of 0.072 among all the three groups
- Convergence insufficiency with accommodative excess are found to be showing higher symptoms in all the three groups.
- The mean age of the people affecting NSBVD with VDU use is 26years +/-3
- Among the gender distribution in three groups, it showed that gender is not statistically significant.

Discussion

The study reported the binocular vision disorders in VDU users and identified the major visual symptoms in VDU users of Bangalore.

Symptoms in VDU users were reported different in different literature. The ocular complaints experienced by VDU users typically include eyestrain, burning sensation and watery eyes, blurred vision and dry eyes [18]. In medicine, a group of diseases or symptoms associated with similar etiologies is called a complex [18]. Thus, the symptoms associated with VDU use are more similar in this respect to a complex than a syndrome. For these reasons, Scheimann have reported certain visual and physical signs and symptoms associated with computer or any other VDU use. According to him, the following are the common symptoms related to VDU use, although there may also be symptoms with use of the eyes after reading or other near tasks. They are eyestrain, headaches, blurred vision, double vision, sleepiness, difficulty concentrating on reading material, loss of comprehension over time, pulling sensation around eyes and movement of the print.

In our study, we have found out that headache with near work was the most common symptom reported (P < 0.013) and trouble keeping attention on reading shows suggestive significance (P < 0.072) in all three groups of VDU.

Patients with visually related VDU symptoms typically have accommodation based problems. Although a significant heterophoria at near may also be an important finding in many cases. According to Gauri Shankar., *et al*. study, visual problems among video display terminal users in Nepal have concluded that Accommodative Infacility and tired eye were the most common abnormalities and symptoms reported [6]. This study was done to evaluate the visual problems, major symptoms and their association among VDT users in Nepal.

D.K Sindal have found out that convergence insufficiency (23%) are frequent among emmetropes with eyestrain in the age group of 10-18years [7]. Robert Montes., *et al*. has found that the Accommodative insufficiency was most prevalent among non presbyopic population. Borsting., *et al*. have reported that Convergence insufficiency and Accommodative insufficiency are common conditions in school age children and are associated with increased symptoms [2].

The three commonest Non strabismic binocular vision anomalies among VDU users in our study were convergence insufficiency with a secondary accommodative excess (27.8%), convergence

insufficiency (14.4%) and accommodative excess (12.2%) Convergence insufficiency associated with accommodative excess is seen more in moderate (26.7%) and heavy users (40%) of VDU. Whereas, convergence insufficiency is seen more in minimum users (26.7%).

The non strabismic binocular vision anomaly which is more in our study is Convergence Insufficiency with a secondary accommodative excess. In this, a secondary accommodative excess is present along with the convergence insufficiency. The assumption is that because of high exophoria, reduced PFV and receded near point of convergence, the patient uses accommodative convergence to help maintain alignment. The accommodative problem is thought to be secondary to excessive use of accommodative convergence to supplement the inadequate PFV. This continual use of excessive accommodative effort may lead to spasm of accommodation. In such cases, the patient may also report blurred vision at distance. At first, this distance blur is transient.

Correlation between symptoms and diagnosed abnormalities in computer workers has variable report. Some studies have agreed the fact that there was a relationship between VDT use and subjective symptoms [20,21]. Some other studies have not shown the correlation [22].

According to COVD questionnaire scoring, we have noticed that the subjects with Convergence insufficiency with a secondary accommodative excess have experienced symptoms more than the other NSBVD and least symptom was reported in accommodative insufficiency. Also, subjects with normal binocular vision are found to be asymptomatic through the COVD questionnaire. So, our clinical findings are significantly correlated with the symptoms reported by the VDU users.

Previous studies have taken either < 4hours or > 8hours. There was no study done with moderate users (who uses VDU between 4 to 8 hours). The observation from the study is that convergence insufficiency with a secondary accommodative excess has found to be more in moderate and heavy users. Whereas, convergence insufficiency is more in minimum users among NSBVD. Previous studies have reported that accommodative disorders are found to be more in VDU users. Here, we have noticed due to the vergence dysfunction there is an over accommodation that happens to compensate the vergence problem, which is mostly seen when the subject works/uses VDU more than 4 hours or equal or more than 8hours over a period of two months. Also, if the person uses VDU <4hours over a period of 2months, it is seen that they possess a good binocular single vision (26.7%) and also they are equally prone to get insufficiency of convergence.

It can be assumed that initially when the person uses VDU over a period of two months or more, there is a vergence dysfunction that happens. With this condition if the person continues his work on VDU due to the vergence dysfunction, to compensate the reduced PFV, he over accommodates which gives a diagnosis of convergence insufficiency associated with a secondary accommodative excess, which is seen more in moderate and heavy users.

Conclusion

We have found that the prevalence of non-strabismic binocular vision anomalies is high around 85% in VDU users. Subjects working with VDU generally present with bothersome symptoms that interfere with their visual performance. In our study, we have noticed that Convergence insufficiency associated with a secondary accommodative excess and headache with near work were the most common non strabismic binocular vision anomaly and symptom reported. COVD questionnaire symptom scoring was correlated with the ocular abnormalities.

Near work produces adaptive changes in the resting states of accommodation and binocular vergence, which may be responsible for different aspects of visual fatigue [23]. Previous studies have reported that near work induces a recession of the near points of accommodation or vergence while others found no change or an approach of the near points. Such discrepancies have been difficult to interpret, because the methods employed differed widely.

The prevalence of convergence insufficiency has been reported to be approximately 3-5% of the population. Incidence increases with additional near work demand. The magnitude of these adaptive changes depends on the individual's initial resting posture; subjects who initially have a far resting posture tend to exhibit greater oculomotor adaptation. Although both accommodative

and vergence tonus tend to shift in the same direction as a result of near work, these changes are not correlated, and they may be responsible for dissociable visual symptoms associated with near work [24].

Our results also suggest that the adaptive variations of accommodative and vergence tonus may have important consequences for visual comfort and performance. The accommodative problem is thought to be secondary to excessive use of accommodative convergence to supplement the inadequate PFV.

The symptoms frequently occur, and management of these conditions can be a satisfying aspect of optometric care. Once the specific diagnosis related with VDU use has been reached, treatment is almost always successful with lenses or added lenses and vision therapy.

Limitation and Future Directions

Sample size was less and consecutive and ergonomic issues were not evaluated for heavy users. Tear film quality was not assessed. There was a lack of assessment on screen size of different VDU and working distance.

The trigger age for NSBVD among VDU users was found to be 26+/-3 years in our study. A future study particularly with this age group would give a generalized result on this.

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