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Effect of stress on convergence insufficiency symptom score (CISS) among optometrists and optometry students

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ABSTRACT

BACKGROUND: This study aimed to measure stress levels and to assess its effect on clinical symptoms related to non-strabismic binocular vision disorders among optometrists and optometry students in India.

MATERIAL AND METHODS: This study aimed to assess the effect of stress on convergence insufficiency symptom score (CISS) among optometrists and optometry students aged 18 to 30 years. An ocular screening of the 50 subjects was done. A CISS survey was administered, followed by the objective assessment of various components of binocular vision. Finally, subjects were asked to fill out the Kessler Psychological Distress Scale (K10) stress questionnaire.

RESULTS: The mean age of the participants was 22.58 (±1.20) years (range = 18–30 years). Pearson's correlation between the near point of convergence (NPC) and CISS score showed a negative relationship of –0.010 ($p = 0.948$), that is, there's no linear relationship between the two variables. NPC, when correlated with the K10 scale, showed no linear relationship between the two (–0.145, $p = 0.233$). There was no significant difference in other parameters, including accommodation, vergences, heterophorias, and accommodative convergence/accommodation (AC/A) ratio. The correlation of stress with CISS was statistically insignificant ($p = 0.90$).

CONCLUSION: This cross-sectional study, including 50 optometrists and optometry students, showed that the effect of stress on the CISS was not statistically significant ($p = 0.90$). This concludes that the result of the responses to the CISS questionnaire is not answered under the influence of stress.

KEY WORDS: stress; binocular vision anomalies; CISS

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INTRODUCTION

A common binocular vision disorder known as convergence insufficiency (CI) is characterized by exophoria that is greater at close range than at far range, a receding point of convergence at close range, and reduced positive fusional vergence (convergence amplitudes) at close range [1]. CI is the most common binocular vision anomaly with a prevalence rate of 3–5%. CI, a non-strabismic binocular vision anomaly, is highly emphasized due to its high prevalence in clinical and community settings [2, 3]. Common symptoms of CI include discomfort, eye strain, headaches, blurred vision, diplopia, sleepiness, difficulty concentrating, movement of print, and loss of comprehension after short periods of reading or performing close activities [4,

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5]. Recent studies surveying the eye care community regarding treatment patterns for persons with symptomatic CI suggest that home-based pencil push-ups are the most commonly prescribed treatment by ophthalmologists and optometrists [6–8]. However, base-in prism reading glasses were found to be no more effective than placebo reading glasses for treating children with symptomatic CI [9].

Binocular vision disorder is often associated with multiple visual symptoms during near activity and can affect educational, occupational, and athletic performance, affecting the quality of life [10, 11]. The convergence insufficiency symptom score (CISS) was designed to quantify convergence insufficiency-related symptom severity [12, 13]. The latest version of CISS has been used to assess and evaluate the effectiveness of the active Convergence Insufficiency Treatment Trial (CITT) [14–17] — a randomized clinical trial curated to achieve the need for further evaluation of the effectiveness of treatments for patients with symptomatic CI. The purpose of this report is to present the design and methodology of the first large-scale randomized clinical trial evaluating treatments for CI, formal definitions, standardized diagnostic and treatment protocols, use of a reliable and valid symptom survey as the primary outcome measure, masked outcome examinations, and the development of a placebo vision therapy/orthoptics treatment. In a study, the group found that a score of ≥ 16 could reliably distinguish children with symptomatic CI from those with normal binocular vision [18]. More recent studies have questioned this value [19], and the adult cut-off is now recommended as ≥ 21 [20].

Stress is our body's response to pressures from a situation or life event called a "stressor". Perception of stress varies from an individual's beliefs and attitudes. Stress often creates erroneous beliefs and assumptions that may lead to faulty thinking and self-defeating behavior [21]. The Kessler Psychological Distress Scale (K10) is a simple measure of psychological distress. The K10 scale has ten questions about emotional states with a scale of 5 levels. If stress is not effectively tackled, it can lead to physical and psychological symptoms, which can endanger the health of individuals [22]. According to recent estimates, 350 million people worldwide suffer from depression. Overall untreated mental health issues are responsible for 13% of untreated diseases globally, according to a 2011 World Health Organization (WHO) report. Mental health issues, particularly depression, are predicted to overtake all other global causes of mortality and morbidity by the year 2030. Undiagnosed or untreated mental illness among college students will have a variety of effects on the person, family, and community because these individuals run a high risk of leaving studies, lacking interest in their studies, and developing depression. They also increase the rate of unemployed individuals, which puts additional strain on families, society, and the community as a whole. Evidence demonstrated that the performance of students dealing with stress is affected, which hinders their ability to manage time and study effectively [23]. Consequently, stress and depression adversely affect well-being and academic performance if not identified early and managed effectively to reduce risk and enhance students' psychological well-being. There are also few coping mechanisms, little awareness of counseling and guidance services, and little use of these services.

A screening scale that, in recent years, has received growing attention and use in epidemiological studies is the K10 [24]. This scale has been validated against highly recognized diagnostic interviews, such as the WHO Composite International Diagnostic Interview (CIDI) and the Structured Clinical Interview for DSM-IV (SCID), in psychiatric epidemiological studies conducted in North America and Australia [25]. The K10 can be used to gauge a person's level of stress over a specific time period, taking into account experiences with annoying problems and thoughts about how unpredictable or uncontrollable life is. Past research has demonstrated that visual impairment can both be a cause of and a result of perceived stress and poor well-being.

Visual impairment may directly increase perceived stress levels by restricting an individual's daily activities (e.g., recognizing people, mobility, reading, driving, and social interaction). However, to the best of our knowledge, there are no studies specifically on anomalies of binocular vision and perceived stress and its association with the CISS questionnaire in the general population or particularly among older adults. Therefore, the goal of this study was to investigate the effect of stress on CISS among optometrists and optometry students.

MATERIAL AND METHODS

This study aimed to assess the effect of stress on CISS among optometrists and optometry students aged 18 to 30 in a tertiary eye center in Goa, India. The sample size of this study was 50 subjects.

The design of the study was a cross-sectional study. The survey and binocular vision assessment were performed after a full explanation of the procedure and objective of the study. This cross-sectional study was conducted for a period of two months, from June 2021 to August 2021.

It was conducted in four phases:

1. Ocular health examination;
2. CISS questionnaire;
3. Comprehensive binocular vision assessment;
4. Stress questionnaire (K10; at the end of data collection).

Written informed consent was obtained from each subject. The study protocol was reviewed and approved by the ethics committee.

The inclusion criteria were: age range between 18 to 30 years old, binocular single vision, and with or without CI according to the CITT study group's guidelines, three signs of CI:

- exophoria at near at least 4Δ greater than at a distance;
- insufficient positive fusional vergence (PFV) at near;
- a receded near point of convergence (NPC) of ≥ 6 cm break [20].

The exclusion criteria were: visual acuity of worse than 6/9 in either eye, constant strabismus, latent or manifest nystagmus, previous treatment of CI in the recent year, high refractive error (myopia > 6 DS; hyperopia > 5 DS; astigmatism > 4 DS), history of refractive error surgery or strabismus, history of any intraocular surgery, use of ophthalmic or systemic medications affecting single binocular vision, and accommodation and history of ocular trauma.

Study design

Ocular health status was assessed using a slit-lamp biomicroscope and +90 DS lens to rule out gross ocular abnormalities. After preliminary examinations and fulfilling the inclusion criteria, the eligible subjects were explained the complete nature of the study, and informed consent was obtained from each subject. Vision-related symptoms were assessed using the validated version of the CISS questionnaire. The CISS questionnaire consists of 15 questions with answers ranging from "never" to "always". It was scored as usual on a 5-point scale with 0 = "never" and 4 = "always" (Tab. 1). After filling, each subject underwent a comprehensive binocular vision assessment (Tab. 2) that included tests of near point of accommodation (NPA), near point of convergence (NPC), accommodative and vergence facilities, negative (NRA) and positive relative accommodation (PRA), negative (NFV)

Table 1. Convergence insufficiency symptom score (CISS) questionnaire

Please answer the following questions about how your eyes feel when reading or doing close work					
	Never	**Infrequently (not very often)**	**Sometimes**	**Fairly often**	**Always**
Do your eyes feel tired when reading or doing close work?					
Do your eyes feel uncomfortable when reading or doing close work? Do you have headaches when reading or doing close work? Do you feel sleepy when reading or doing close work? Do you lose concentration when reading or doing close work? Do you have trouble remembering what you have read? Do you have double vision when reading or doing close work? Do you see the words move, jump, swim or appear to float on the page when reading or doing close work? Do you feel like you read slow?					
Do your eyes ever hurt when reading or doing close work? Do your eyes ever feel sore when reading or doing close work? Do you feel a "pulling" feeling around your eyes when reading or doing close work?					
Do you notice the words blurring or coming in and out of focus when reading or doing close work?					
Do you lose your place while reading or doing close work? Do you have to re-read the same line of words when reading?					
	× 0	× 1	× 2	× 3	× 4

Table 2. Ocular examination parameters

		OD	OS	OU
Visual acuity Objective refraction	Distance Near			
Subjective refraction				
JCC Duochrome WFDT Maddox Rod Test	90	Distance	Near	Correction
NPA	180	OD	OS	OU
NPC	Blur recovery Blur	OU		With red filter
Accommodative facility	Break Recovery difficulty with	OD	OS	OU
Cycles/min	±			
NFV	Distance	Blur	Break	Recovery
	Near	Blur	Break	Recovery
PFV	Distance	Blur	Break	Recovery
	Near	Blur	Break	Recovery
Vergence facility	Difficulty with		Cycles/min	
	3PDBI/12PDBO			
NRA	OU	S.Blur		
PRA	OU	S.Blur		
AC/A Ratio → = IPD (cms)+ NFD (mts)(Hn-Hf) MEM Retinoscopy Randot Stereotest IPD				

OD (*oculus dexter*) — right eye; OS (*oculus sinister*) — left eye; OU (*oculus uterque*) — both eyes; JCC — Jackson's cross cylinder; WFDT — Worth Four Dot Test; NPA — near point of accomodation; NPC — near point of convergence; NFV negative fusional vergence; PFV — positive fusional vergence; NRA — negative relative accommodation; PRA — positive relative accommodation; AC/A — accommodative convergence/accommodation; IPD — interpupillary distance; NFD — near fixation distance; MEM — monocular estimation method

and positive fusional vergence (PFV), and monocular estimation method (MEM).

Uncorrected and best-corrected visual acuity was assessed with the help of Snellen's chart at a distance of 3 meters. Objective refraction was done using an auto refractometer (NIDEK AR-310). Subjective refraction was done to obtain the best correction of visual acuity if needed. Subjects with the refractive error were balanced using duo-chrome. The cylindrical powers were refined with the help of the Jackson cross cylinder (JCC) and were binocularly balanced with the 4 prism diopter base down (4PDBD) technique. Near heterophoria was evaluated using the alternate cover test at 40 cm and also the Maddox rod test to rule out the amount of near (40 cm) and distance (3 meters) heterophoria with the help of a pen torch at 180 and 90 axes.

NPC was measured using a single target of N8 on the Gulden fixation stick. NPA (push up method) was measured with the same target monocularly and binocularly. Monocular and binocular accommodative facilities were measured first for the right eye and then for the left eye using +2 DS and –2 DS lenses and accommodative target N8 at a distance of 40 cm for one minute. The accommodative response was measured for the right eye at 40 cm using the MEM retinoscopy. The amount of lead (against) and lag (with) were measured with the help of plus and minus lenses to neutralize the retinoscope reflex at a distance of 40 cm.

NRA and PRA were measured binocularly, adding plus and minus lenses, respectively, in ± 0.25 steps at 40 cm until sustained blur was obtained. The target used was N8 on the near reading chart. The accommodative convergence/accommodation (AC/A) ratio was measured using the heterophoria method. PFV and NFV were measured using base-out and base-in prisms, respectively, of a prism

Table 3. The Kessler Psychological Distress Scale (K10) questionnaire

The following questions ask about how you have been feeling during the past 30 days. For each question, please circle the number that best describes how often you had this feeling					
During that month, how often did you feel:	**All of the time**	**Most of the time**	**Some of the time**	**A little of the time**	**None of the time**
Tired out for no good reason?					
Nervous?					
So nervous that nothing could calm you down?					
Hopeless?					
Restless or fidgety?					
So restless that you could not sit still?					
Depressed?					
So depressed that nothing could cheer you up?					
That everything was an effort?					
Worthless?					

bar at 40 cm for near and 6 meters for distance. The vergence facility was measured using a combination of 3PD base-in and 12PD base-out loose prisms from the trial case with an N8 target for 1 minute. The diagnosis of non-strabismic anomalies of binocular single vision (BSV) was based on the criteria by Scheiman and Wick.

Following the comprehensive examination, under the guidance of a clinical psychologist, the subjects were asked to fill out the K10 questionnaire to investigate their stress level (Tab. 3). The K10 is a validated scale that has been extensively used to assess perceived stress in recent years. The scale used a five-value response option for each question that was scored from five through to one — the time, most of the time, some of the time, a little of the time, and none of the time. These responses were later scored from five through to one, respectively. The maximum score obtained is 50, indicating severe distress, and the minimum score is 10 indicating no distress.

The 10-item (or K10) scale

In the Australian Bureau of Statistics surveys, the score groupings and categories of psychological distress were developed on the work of the Clinical Research Unit for Anxiety and Depression. Scores are grouped into four levels of psychological distress. K10 total score levels with 10–15 were considered low scores, 16–21 levels were considered moderate scores, 22–29 were considered high scores, and 30–50 levels were considered very high. There are other methods of categorizing the K10 stress scores, but the one mentioned above was simplified for statistical purposes. According to CRUFAD and GP care score grouping and categorization, the level from 10–19 were considered to be likely well, from 20–24, to have a mild mental disorder, level 25–29 as a moderate mental disorder, and 30–50 as a severe mental disorder. This type of grouping is mainly used in primary health settings to assist in monitoring distress rather than identifying the presence of a disorder. K10 scoring categories used by specialist mental health services for people who are already in specialist care are as follows 10–19, indicating that the patient may currently not be experiencing significant feelings of distress.

20–24 as may be experiencing mild levels of distress consistent with a diagnosis of mild depression and/or anxiety disorder. 25–29 diagnosed with moderate depression and/or anxiety disorder. 30–50 diagnosed with severe depression and/or anxiety disorder. Plain English categorization of the K10 scale developed by AMHOCN and the Mental Health Association of NSW was utilized. In this system, grouped scores are categorized into three levels of psychological distress:

- 10–15 — the patient might currently not be experiencing significant feelings of distress;
- 16–30 — the patient may experience moderate symptoms of depression and/or anxiety. These symptoms might cause some distress in their everyday life;
- 31–50 — likely that the patient experienced some form of depression and/or anxiety.

Statistical analysis

The statistical analysis was performed with SPSS 14.0 for windows evaluation (http://www.ibm.

com/analytics/spss-statistics-software). The analysis was restricted to those between 18 to 30 years of age as the focus of this study was on young adults. Pearson's correlation was used to analyze the correlation between the CISS and K10 stress scores. CISS score was also correlated with the various binocular vision components such as NPC, NPA, accommodative facilities, vergence facilities, heterophorias, and AC/A ratios. All these various components were also correlated with the K10 scores. p values less than 0.05 were considered statistically significant.

RESULTS

Fifty subjects with or without CI were selected for this study. Out of which 46 (92%) subjects presented with receded near point of convergence 6cms. In all, 50 subjects completed the ocular examination, questionnaire, and further comprehensive binocular vision testing. The mean age of the participants was 22.58 (± 1.20) years (range = 18–30 years), and 86% were female. Overall, 13(26%) subjects had a high CISS score of > 21 in young adults. 19 (38%) Subjects reported low K10 scores, 8 (16%) with moderate K10 scores, and 3 (6%) with high K10 scores. The remaining 40% were considered very low-stress levels since their score was < 9. Pearson correlation between the near point of convergence and CISS score a negative relationship of –0.010 (p = 0.948), with no linear relationship between the two variables. When correlated with the K10 scale, NPC showed no linear relationship between the two (–0.145, p = 0.233). The baseline clinical data of the correlation of CISS and K10 between all the variables are given in Table 4. The mean and standard deviation of binocular vision variables are shown in Table 4. No statistically significant difference was observed in other parameters, including near PFV, NPC, vergence facility, and AC/A ratio. The correlation of stress with CISS was statistically insignificant, with a p-value of 0.90. The association between CISS and perceived stress assessed by χ^2 is shown in Table 5. Out of 19 (38%) subjects who got a grade of 0, 15 (78.9%) subjects who scored < 21 in CISS, and 4 (21%) subjects were convergent insufficient subjectively. 19 (38%) subjects who scored a low-stress score 14

Table 4. Correlation and p-values of convergence insufficiency symptom score (CISS) and the Kessler Psychological Distress Scale (K10) compared with binocular vision components with their mean and standard deviations

	CISS		K10 Stress Scale		Mean ± SD
	R	p	R	p	
Near point of convergence	–0.010	0.948	–0.145	0.233	9.35 ± 2.12
Near point of convergence (with red filter)	0.258	0.070	–0.137	0.342	10.7 ± 3.58
Near point of accommodation (OD)	–0.105	0.498	–0.036	0.803	10.6 ± 1.65
Near point of accommodation (OS)	–0.017	0.906	–0.270	0.058	10.9 ± 1.90
Near point of accommodation (OU)	–0.196	0.172	–0.051	0.724	10.1 ± 1.37
Accommodative facility (OD)	–0.070	0.629	0.119	0.409	12.0 ± 5.87
Accommodative facility (OS)	–0.274	0.054	–0.047	0.748	12.2 ± 6.10
Accommodative facility (OU)	–0.027	0.852	0.058	0.689	10.5 ± 5.08
Maddox rod (DISTANCE)	0.126	0.385	0.166	0.250	0.53 ± 2.34
Maddox rod (NEAR)	0.093	0.522	0.083	0.565	0.11 ± 2.69
Vergence facility	0.105	0.470	0.117	0.419	10.62 ± 5.06
Negative relative accommodation	–0.044	0.764	0.089	0.538	3.57 ± 0.77
Positive relative accommodation	–0.182	0.205	–0.057	0.696	5.35 ± 1.72
Negative fusional vergence (DISTANCE)	–0.025	0.865	–0.138	0.339	11.74 ± 6.66
Negative fusional vergence (NEAR)	–0.122	0.397	–0.038	0.794	22.54 ± 9.73
Positive fusional vergence (DISTANCE)	0.255	0.073	0.315	0.026	20.14 ± 12.56
Positive fusional vergence (NEAR)	0.110	0.446	0.047	0.748	30.68 ± 13.34
Monocular estimate method (OD)	–0.085	0.555	–0.126	0.383	0.65 ± 0.17
Monocular estimate method (OS)	0.036	0.805	–0.090	0.534	0.62 ± 0.18
AC/A	–0.151	0.295	–0.162	0.260	5.92 ± 1.28

SD — standard deviation; AC/A — accommodative convergence/accommodation; OD (*oculus dexter*) — right eye; OS (*oculus sinister*) — left eye; OU (*oculus uterque*) — both eyes;

Table 5. Correlation of the Kessler Psychological Distress Scale (K10) with convergence insufficiency symptom score (CISS)

	CISS 0	Grade 1	Total
K10 Stress Grade			
0	15 (78.9%)	4 (21%)	19 (38%)
1	14 (73.6%)	5 (26.3%)	19 (38%)
2	6 (66.6%)	3 (33.3%)	9 (18%)
3	2 (66.6%)	1 (33.3%)	3 (6%)
Total	37 (74%)	13 (26%)	50

(73.6%) got 0 grade and 5(26.3%) were convergent insufficient. 9 (18%) subjects scored moderate stress score 6 (66.6%) scored 0 CISS score and 3 (33.3%) were subjectively convergent insufficient. 3 (6%) subjects scored a high-stress grade, 2 (33.3%) subjects scored zero CISS grade, and one subject reported convergence insufficiency. Also, the refractive component was statistically insignificant, with a p-value of 0.36 (CISS).

DISCUSSION

This study, including 50 optometrists and optometry students, revealed that 13 (26%) subjects had a high CISS score > 21 in young adults. This study demonstrates that symptoms often associated with binocular anomaly are also common in young adults without clinical signs of poor convergence, accommodation, or fusion and that most subjects with the clinical signs of CI (reduced convergence and fusion range) have no symptoms. To the best of our knowledge, this is the first study to investigate the effect of stress on the CISS questionnaire in the young adult population. Different scores are utilized to differentiate between individuals with symptomatic CI and those who have normal binocular vision when using the CISS as a tool to determine treatment effects in children (≥ 16) and adults (≥ 21) [19–21]. The use of the CISS has been validated in studies on treatment trials of children and adults [21, 22] but some researchers do not agree that the CISS is a good tool even for that purpose. It might be a practical way to monitor symptoms in cases of well-established, symptomatic CI or in the research circumstances for which it was intended. Convergence insufficiency has been reported to be the most common non-strabismic anomaly of binocular vision in previous reports. If it had been used to screen our student population without a history of issues, 25% of students would have been referred for further investigation, but even so, 65% of the true CIs would have been missed. It may be a useful method of monitoring symptoms in established, symptomatic CI or for the research contexts for which it was designed.

Even after adjusting for non-ocular causes of symptoms, 9% of students would have been referred, but 88% would have been missed. Only the most severe form of objective visual impairment was linked to higher levels of perceived stress when objective measures were used, whereas mild levels of subjective visual impairment were linked to higher levels of perceived stress. It is unclear why there was a stronger correlation between subjective visual impairment and felt stress. Yet, even when their vision is normal or nearly normal based on objective examination, those with higher stress sensitivity or lower levels of resilience may be more prone to claim to have more visual impairments. Stress and the convergence insufficiency score had only a weak association in the current investigation.

The K10's questions centre on sadness and anxiety, which are typically the subjects of psychological distress scores. Just because it is challenging to identify people with psychosis with a short questionnaire, there are no questions intended to do so. This would be significant if the K10 were employed as an outcome measure in patients with psychosis, but it is not a concern when it is applied to patients with common mental disorders. Because people with psychosis do experience distress, the K10 may still be suitable when used to gauge a population's need for community mental health care.

Although our results appear to be reliable, there are certain limitations that need to be taken into account. Hence, the small sample size, high male-to-female ratio, and wide age range may be to blame for the CISS results' unpredictability. Also, we did not assess the subjects' levels of dry eye or blinking; as these factors may be connected to CI, additional research may be required to advance our understanding of the matter.

CONCLUSION

The effect of stress on the CISS was not statistically significant, according to this cross-sectional study of 50 optometrists and optometry students ($p = 0.90$). Additionally, it demonstrated that, when compared to the CISS score and K10 stress score, there was no linear link between the binocular vision variables NPC, NPA, NPA, PRA, accommodative and vergence capacity, AC/A ratio, and latent phorias. This suggests that the results of the CISS questionnaire replies were not provided while under the impact of stress.

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Conflicts of interest

The authors declare no conflict of interest.

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