# Article • The Effect of Stress on Visual Function amongst School-Going Children in Mumbai

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## ABSTRACT

**Background:** The prevalence of stress in school-aged children is reported to be an astonishing 88%. The literature supports an association between functional vision and stress. The objective of this study was to evaluate visual function skills and their association with stress in school-aged children in Mumbai.

**Methods:** A cross-sectional study was conducted on students aged 9 to 15 years in Mumbai. Subjects with no history of ocular disease, surgery, trauma, systemic disease, or ocular or systemic drug use that might induce stress were included. Pre-diagnosed cases of depression, anxiety, and any systemic or ocular syndrome were excluded from the study. All subjects underwent detailed ocular examination that included slit lamp evaluation, subjective and objective refraction, and undilated retinal evaluation. Subjects were then assessed for colour vision, stereoscopic acuity, contrast sensitivity, and confrontation visual fields, followed by the Stress in Children (SiC) questionnaire.

**Results:** One hundred subjects (mean age 12.3 ± 2.1 years) completed the study; 59% were females. Global mean score (GMS) showed a similar level of stress in females (1.95 GMS) and males (1.94 GMS). Increased stress was correlated with an increase (improvement) in the contrast sensitivity (r = 0.007) and stereo acuity (r = 0.096). GMS scores between astigmatism (2.11 ± 0.37), myopia (1.96 ± 0.24), emmetropia (1.94 ± 0.32), and hyperopia (1.81 ± 0.19) showed no statistical significance (p = 0.549) but were clinically significant. There was no difference found in colour vision and visual field throughout the sample population.

**Conclusions:** Increase in stress was found to be correlated with an improvement in contrast sensitivity and stereo acuity. However, there were no changes found in colour vision and visual fields. Based on refractive error, those with astigmatism showed the highest level of stress, followed by myopia, emmetropia, and hyperopia, respectively.

**Keywords:** childhood stress, contrast sensitivity, refractive error, stereo acuity, stress, visual function

## Introduction

The International Classification of Diseases and Related Health Problems (ICD-10) describes stress as physical and mental strain.[1] The diagnosis of stress is made when the problems related to stress cannot be classified elsewhere, such as those related to socioeconomic and physical circumstances or employment or unemployment.[1] Childhood stress can be present in any setting that requires the child to adapt or to change. Stress can be caused by positive changes, such as starting a new activity, but it is most commonly linked with negative changes, such as illness or death in the family.[2,3]

Children learn how to respond to stress as they grow and develop. Many stressful events that an adult can manage may cause stress in a child. As a result, even small changes have an impact on a child's feelings of safety and security.[4] Pain, injury, illness, and other stress-causing changes are stressors for children.[4,5]

In acute stress, the body's stress system is activated for a small amount of time due to a temporary stimulus. This stress may have lasting biological or behavioural effects if it is severe, but generally, the human stress response system is well equipped for management. In chronic stress, the body's stress system is activated frequently or for a prolonged period in response to a persistent stimulus. This stress may have detrimental effects on the brain and behavior.[6]

**Table 1. Causes of Stress in School Children**

| |
|---|
| Worrying about schoolwork or grades |
| Juggling responsibilities, such as school and work or sports |
| Problems with friends, bullying, or peer group pressures |
| Changing schools, moving, or dealing with housing problems or homelessness |
| Having negative thoughts about themselves |
| Going through body changes, in both boys and girls |
| Seeing parents go through a divorce or separation |
| Money problems in the family |
| Living in an unsafe home or neighbourhood |

There are various causes of stress that can affect the way a child thinks, feels, or acts in various situations. As they grow and develop, children learn how to respond to stress. Stressful events that an adult can manage will cause stress in a child on a greater scale; even small changes can impact feelings of safety and security.[4] Table 1 shows various stressors that affect children.

Eighty-two percent of Indian adults suffer from stress.[7] Watode et al. reported an overall stress prevalence of 87.7% among school adolescents in Delhi.[8] In Kerala, 93% to 100% of the children aged 4 to 17 years showed medium to moderate stress, while 1.9% had severe stress, as cited by Bindu & Nair.[9]

Rushda et al. studied 70 patients with stress. Of that group, 47% showed defects in contrast sensitivity, 43% showed a decrease in visual acuity, and 36% showed a decrease in glare sensitivity, while 99% of patients exhibited no defect in visual field or colour vision. It has been previously recorded that increased ocular anomalies lead to an increase in stress.[10] Thus, this provides a firm foundation to demonstrate this bi-directional relationship between ocular anomalies and stress.

Munoz et al. found that stress did not significantly affect visual acuity, contrast sensitivity, or visual fields; however, in females, chronic stress did affect visual attention.[11] Wesner et al. studied contrast sensitivity in patients with seasonal and non-seasonal depression. The results suggest that clinical depression can increase contrast sensitivity while stimulating strong parvocellular responses. The stimulation used was luminance and temporally modulated luminance CS. These enhancements were related to differences in retinal functionality. Components that link neuro-modulatory activity to retinal signal processing were proposed.[12]

Kumaran et al. evaluated the quality of life of children with uncorrected refractive error and showed that children faced problems in performing their day-to-day activities. Improvement was shown after providing correction.[13] The purpose of the current study was to evaluate the effect of stress amongst school-age children who visited a tertiary eye center in Mumbai.

## Methods

In this cross-sectional study, students from various schools in Mumbai who visited Lotus Eye Hospital or who were part of the Mumbai Eye Care Campaign were recruited. To be included in the evaluation, the student had to be between 8 and 15 years of age with no ocular abnormalities or history of ocular disease, ocular surgery, systemic disease, ocular trauma, and ocular or systemic drug use that might be the reason for induced stress. Pre-diagnosed cases of depression, anxiety, and any systemic or ocular syndrome were excluded from the study.

The participants and their legal guardians were familiarised with the study protocol and were allowed to ask any queries related to their participation. After explaining the study procedures and risks/benefits, the legal guardians provided written consent. Visual acuity was measured as follows: distance vision chart (LogMAR chart) held at 4 meters and near vision (M chart) at the child's reading distance performed in ambient room light conditions. All subjects underwent detailed ocular examination that included slit lamp evaluation and undilated retinal evaluation by an ophthalmologist. Subjects who fulfilled the inclusion and exclusion criteria were then assessed for colour vision (Ishihara pseudo-isochromatic plates), stereoscopic acuity (stereo fly test), contrast sensitivity at 1M (Pelli-Robson contrast sensitivity chart with illumination of 85cd/mm2), and confrontation fields. The examiner asked the patient to count fingers stepwise from the non-seeing area to the seeing area in all quadrants. The Stress in Children (SiC) questionnaire was administered by a trained optometrist (Appendix).

The SiC questionnaire was constructed to assess stress in children. Results were compared with established measures of anxiety, depression, anger, disorderly behaviour, and negative self-perception. It also assessed the degree of received distress and the presence of symptoms or low levels of well-being, an important feature of coping and social support. This questionnaire was validated using the Beck Youth Inventories of Emotional and Social Impairment (BYI).[14]

The score for every question was scored between 1 and 4 based on frequency: 1 (never), 2 (sometimes), 3 (often), and 4 (very often). For questions 3, 4, 8, 10 to 14, 16, 17, 19, 20, and 21, the scores were reversed: 1 (very

often), 2 (often), 3 (sometimes), 4 (never). A maximum of two questions could be left unscored, and then an average was calculated for the scored questions. This was later considered as the global mean score (GMS).[14]

The stress-level groups were calculated by dividing the range of values into quartiles; four values were obtained. Values between the minimum value that could be obtained and the first quartile (Q1) were denoted as the "no-stress group," values between Q1 and the second quartile (Q2) were denoted as the "low-stress group," values between Q2 and the third quartile (Q3) were denoted as the "moderate-stress group," and values between Q3 and the maximum value that could be obtained were denoted as the "severe-stress group."

## Results

The population was normally distributed according to the Kolmogorav-Smirnov test. Pearson's correlation (2-tailed) was tested using a statistical package for the social sciences software SPSS (version 16.0). A total of 100 students were recruited and completed all study procedures. The mean age was 12.31 ± 2.14 years, of which 41 were males, as shown in Figure 1. Detailed ocular examinations of all of the subjects were found to be within normal limits.

Table 2 shows that the level of stress in females (1.95 GMS) was similar compared to males (1.94 GMS, p> 0.05). There was a low positive correlation between age and stress (r=0.102), a weak positive correlation between visual acuity and stress (r=0.116), and a weak negative correlation between colour vision and stress (r=-0.1204, Table 3)

An increase in stress was correlated with an improvement in contrast sensitivity (r=0.007). Twenty-one participants were found to have a contrast sensitivity of about 1.20 to 1.35 log units. It increased from 1.50 to 1.65 log units with stress for a population of 71. An increase in stress was also slightly correlated with improvement in stereopsis (r = 0.096).

**Table 2. GMS Compared to Given Variables using T-Test (Paired)**

| Variable | P-Value |
|---|---|
| Male | 0.355 |
| Female | 0.355 |
| Refractive Error | 0.549 |

**Table 3. GMS Compared to Given Variables using Pearson's Correlation (2-Tailed)**

| Variable | Pearson's Correlations (r) (2-tailed) |
|---|---|
| Age | 0.102 |
| Visual Acuity | 0.116 |
| Contrast Sensitivity | 0.007 |
| Stereo Acuity | 0.096 |
| Colour Vision | -0.1204 |

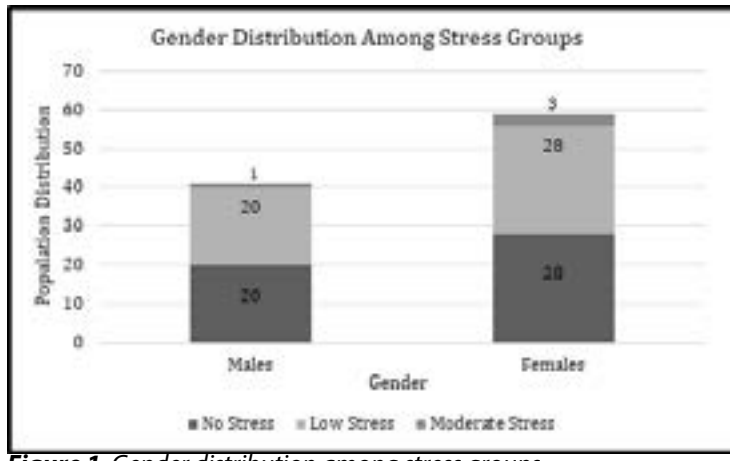


***Figure 1.*** *Gender distribution among stress groups*

Table 4 shows a comparison of GMS and types of refractive error. Individuals with astigmatism were found to have a higher amount of stress (2.11 GMS) compared to other refractive errors, but this was not statistically significant (p>0.05).

Table 5 shows visual functions across the four stress groups. Stereo acuity and contrast sensitivity increased as the stress level group increased from no stress to moderate stress. There was no statistical significance seen in either visual field or colour vision throughout the population.

## Discussion

The study results showed that stress was found to be higher in children with astigmatism, followed by myopia, emmetropia, and hypermetropia. An increase in stress was correlated with an improvement in contrast sensitivity and stereo acuity. There was no difference found in colour vision and visual field when compared with the degree of stress.

Stress may occur at any age; the prevalence has been reported widely.[1] Various studies suggest that bullying behaviour is a serious problem among school-age children and adolescents and has both short- and long-term effects on the individual.[15] However, this area remains to be explored in further detail. Concerns have been reported about friends teasing spectacle wearers' appearance.[16] In India, "teased by other children" was reported to be the single most common cause of non-wear of spectacles.[17] It was also reported that stress related to psychological and physical factors, such as being a target of bullying, activated the stress system, centered on the hypothalamic-pituitary-adrenal (HPA) axis.[16]

**Table 4. Multiple Comparison Between all Refractive Errors using ANOVA (1-Way)**

| (I) Group | (J) Group | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| Myopia | Hyperopia | 0.14929 | 0.19788 | 1.000 | -0.3837 | 0.6823 |
| | Emmetropia | 0.01467 | 0.09028 | 1.000 | -0.2285 | 0.2578 |
| | Astigmatism | -0.14571 | 0.15177 | 1.000 | -0.5545 | 0.2631 |
| Hyperopia | Myopia | -0.14929 | 0.19788 | 1.000 | -0.6823 | 0.3837 |
| | Emmetropia | -0.13462 | 0.18299 | 1.000 | -0.6275 | 0.3583 |
| | Astigmatism | -0.29500 | 0.21993 | 1.000 | -0.8874 | 0.2974 |
| Emmetropia | Myopia | -0.1457 | 0.09028 | 1.000 | -0.2578 | 0.2285 |
| | Hyperopia | 0.13462 | 0.18299 | 1.000 | -0.3583 | 0.6275 |
| | Astigmatism | -0.16038 | 0.13177 | 1.000 | -0.5153 | 0.1945 |
| Astigmatism | Myopia | 0.14571 | 0.151199 | 1.000 | -0.2631 | 0.5545 |
| | Hyperopia | 0.29500 | 0.21993 | 1.000 | -0.2974 | 0.8874 |
| | Emmetropia | 0.16038 | 0.13177 | 1.000 | -0.1945 | 0.5153 |

**Table 5. Visual Functions across Different Stress Groups**

| Stress Groups | Sample Size | GMS (Min, Max) | Stereo Acuity [Sec of ARC] (Min, Max) | Right Eye Contrast Sensitivity [Log Units] (Min, Max) | Left Eye Contrast Sensitivity [Log Units] (Min, Max) | Both Eyes Contrast Sensitivity [Log Units] (Min, Max) |
|---|---|---|---|---|---|---|
| Total Population | 100 | 1.69 ± 0.13 (1.26, 2.80) | 50.80 ± 23.12 (200, 40) | 1.47 ± 0.16 (1.05, 1.65) | 1.47 ± 0.15 (1.20, 1.65) | 1.52 ± 0.17 (1.20, 1.8) |
| No Stress | 48 | 1.69 ± 0.13 (1.26, 1.86) | 53.99 ± 29.40 (200, 40) | 1.47 ± 0.18 (1.2, 1.65) | 1.46± 0.17 (1.20, 1.65) | 1.50 ± 0.2 (1.20, 1.8) |
| Low Stress | 48 | 2.15 ± 0.16 (1.89, 2.50) | 48.54 ± 15.40 (100, 40) | 1.47 ± 0.17 (1.05, 1.65) | 1.46 ± 0.15 (1.20, 1.65) | 1.53 ± 0.16 (1.20, 1.80) |
| Moderate Stress | 4 | 2.65 ± 0.1 (2.50, 2.80) | 40 ± 0 (40, 40) | 1.58 ± 0.09 (1.50, 1.65) | 1.56 ± 0.09 (1.50, 1.65) | 1.61 ± 0.08 (1.50, 1.65) |
| Severe Stress | 0 | - | - | - | - | - |

Streff syndrome, also known as juvenile bilateral functional amblyopia, non-malingering syndrome, and early adaptive syndrome, is a bilateral functional loss of vision with a relatively rapid onset. This disorder is most common in the school-age population and tends to affect girls more than boys at a ratio of 2:1, although it has also been reported in adults. It appears that visual stress is a significant component that can be amplified by others' emotionally or physically stressful situations or events. There is a decrease in acuity present with no signs of organic pathology and little, if any, refractive error.[18]

Morjaria et al. in Saudi Arabia show gender discrimination regarding wearing glasses, where the majority of girls were more likely to express parental disapproval as a reason for non-wear than boys.[2] Other studies done in India show that parents were concerned that wearing spectacles would adversely affect the marriage prospects of their daughters and that girls would be discriminated against for wearing spectacles. Another study undertaken in India explained these views, indicating that parents considered spectacle wear to imply a disability. Thus, this could be the reason that parents in India are more likely to stop girls from wearing spectacles and have greater anxiety about girls wearing spectacles.[2,3]

In previous research conducted in India, women are said to be more stressed compared to men, which is not in agreement with our study.[3] Rees et al. conducted a study on subjects (18-35 years) previously diagnosed with stress. The results showed that there was a decrease in visual acuity. Our study concluded that there was a weak correlation of the effect of stress on visual acuity. Rees et al. found that distress, specifically related to vision, was an indicator for the precursor of anxiety and stress.[19] The study indicated that a stressed patient sees the world more in grey tones, which is well illustrated with the phrase "feeling blue" as one of the indicators of a sense of sadness.[19] Thus, it can be phrased that stress is a mental disease that is significantly related to the brain and, in some

serious way, interferes with the ability of an individual to have clear vision.19

Rushda et al.[10] performed a study on 70 older patients with stress. They noted that there was no defect in colour vision and visual fields. Similar results were seen in our study, where participants recognised all of the plates except one. There was no visual field defect detected on gross visual field testing throughout our sample population. In our population, we found one male with a colour vision defect; however, a more sensitive test to detect defects in L, M, and S cones separately could be performed to understand the effect of stress on colour perception. In our study, the visual field was performed using gross visual field testing (confrontation and gross fields) due to limited access. Further studies could be performed using automated visual field testing in order to understand the impact of stress on visual fields better.

Wesner et al.[12] evaluated the relationship between clinical stress and contrast sensitivity. Contrast sensitivity was measured by using an electroretinogram (ERG). The results showed that with an increase in clinical stress, there was an improvement in contrast sensitivity; our study showed similar results. These findings suggest that clinical depression can improve contrast sensitivity when stimuli excite strong parvocellular responses.[12] These enhancements implicate differences in retinal functionality. Mechanisms that link neuro-modulatory activity to retinal signal processing are proposed.

Katz et al.[20] did a study to understand psychological stress in childhood and myopia development by evaluating adults retrospectively. The same data, when running through factor analysis, showed that the myopia group had a significantly higher score on the "stress-fear-abuse" scale than the emmetropia group. Explanatory analysis suggested that myopes had lower self-esteem, were lonelier, experienced more criticism about physical aspects of themselves, had higher weight, and sat closer to the television. Emmetropes, as compared to myopic participants, reported receiving less overall childhood criticism and less often had parents with health, emotional, addiction, or marital problems. The evaluation concluded that patients with myopic refractive correction had more childhood stress.[20] Research to explore these findings further might be more helpful in understanding this relation.

Hyperopic infants show small but reliable deficits in many visual-cognitive, spatial, visuomotor, and attention tests, which are first identifiable in the second year of life and may persist through the beginning of the school years.[21] Thus, delay in development and the potential negative effect of hyperopia in educational achievement can be causes leading to stress in school children. In our study, stress was found to be the least for the hyperopic group, which can perhaps be attributed to fewer numbers compared to other refractive populations.

As per the previous studies, bullying due to cosmetic appearance is related to wearing spectacles.[15-17] Involving and educating parents regarding their child's need for spectacle correction might tremendously improve compliance and could be a profound step in providing moral support to the child.[22]

Kowalski presented a case series involving young girls under 15 years old who were diagnosed with stress. The case series showed decreased visual acuity (worse than 20/40) at distance and near monocularly as well as binocularly, low hyperopia of around 0.50 diopters, decreased Randot stereopsis, constricted confrontation visual fields, and colour vision deficits. He stated that some of the subjects might have been malingering, but most of them did not have any "secondary gain;" thus, it was unlikely that they were consciously feigning these symptoms. He suggested that the ocular complaints reported could be because of some underlying stress or disturbance.[23] This is not in agreement with the current study, as an increase in stress was correlated with better stereo acuity.

More studies with larger sample sizes should be conducted to assess the determinants of spectacle use and the barriers to spectacle use, as these could be confounding factors. Stress should be classified and compared with visual functions and refractive error in order to understand these relations in more detail.

## Conclusion

This study indicates that there was an improvement in stereo acuity and contrast sensitivity with an increase in stress. This suggests a relationship between stress and visual functions. It is important not only to evaluate physical changes, but also to monitor the mental health of the child. A child-friendly environment must be incorporated, and stress scores must be regularly evaluated using a globally available questionnaire.

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## Appendix

Stress in Children (SiC) Questionnaire:[14]

1. I get angry
2. I get headaches
3. I like going to school
4. I feel calm and happy
5. I get stomach pains
6. I feel lonely
7. I get sad
8. I like to be at school
9. The other kids tease me
10. I fall asleep easily at night
11. I feel calm
12. Things work out as I have planned
13. I feel happy
14. When I am happy, I show it
15. Sometimes I do not reach the goal I have a planned for
16. When I have a hard time, it helps being with friends
17. When I am sad, I show it
18. Sometimes I can't manage with the things I have to do
19. When I have a hard time, there is an adult to talk to
20. If anyone teases me, I will object
21. It is easy to concentrate during lessons at school