Stress-Related Changes in Vision

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Abstract

This study delves into the intricate topic of stress and its profound impact on human health within the contemporary context of our fast-paced world. Stress, characterised as a multifaceted phenomenon, exerts its influence on individuals' physical and mental well-being, presenting itself through a myriad of manifestations, including mood swings, bodily discomfort, and psychological symptoms such as anxiety and irritability. This study aims to deepen understanding of the relationship between stress and visual functions, particularly exploring the potential benefits of stress reduction exercises. The research encompassed a cohort of 65 participants, albeit with eight instances of dropout. The research methodology employed a dual-pronged approach utilizing the Perceived Stress Questionnaire (PSQ) alongside a meticulously designed research-based questionnaire to evaluate stress levels and visual impairments. The study uses a longitudinal intervention methodology. The study consists of an initial measurement phase, transitioning seamlessly into a two-month intervention period characterised by incorporating stress alleviation exercises with subsequent follow-up assessments. Hypotheses were meticulously formulated to scrutinize the correlation between stress levels and ocular disorders and evaluate the efficacy of stress-mitigating interventions, with comprehensive statistical analyses employing correlation analysis and one-sided paired t-tests.

Keywords: stress; vision; stress-related; visual function; visual health

1. Review of literature

1.1. The psychological impact of stress on the human body

Stress is an integral part of modern life and plays a pivotal role in influencing an individual's physical and mental well-being. This intricate phenomenon can trigger a broad spectrum of physical and psychological reactions, often with long-term consequences for overall health. Each type of stress manifests through a range of symptoms. Common stress indicators include mood swings, sweaty palms, decreased libido, diarrhoea, sleep disturbances, digestive issues, dizziness, anxiety, frequent nausea, headaches, low energy, and others.

Immediate physiological changes, expertly timed, can have lasting consequences. Chronic stress can lead to sustained activation of the cardiovascular system, with a cumulative impact on cardiovascular health. Increased blood pressure and accelerated heart rate may contribute to heart and vascular diseases such as hypertension and atherosclerosis [1].

Stress also affects the immune system, potentially rendering the body less effective in responding to infections and illnesses. Long-term stress can suppress immune responses, increasing infection susceptibility and prolonging wound healing. Additionally, stress may negatively impact inflammatory processes in the body, linked to various chronic diseases, including rheumatoid arthritis and autoimmune conditions [2].

The nervous system is another crucial player in the stress response [3]. According to the American Psychological Association [4], chronic stress may result in long-term exhaustion as the autonomic nervous system continues to trigger physical responses, causing wear and tear on the body. It is not just about what chronic stress does to the nervous system but what constant nervous system activation does to other bodily systems, which is becoming problematic. Stress can influence the structure and function of the brain, particularly areas associated with emotions and memory, contributing to the development of mental disorders such as depression and anxiety. Individuals under chronic stress may experience emotional fluctuations, irritability, and loss of motivation. Migraines, headaches, and concentration problems may also be associated with prolonged stress.

Stress and intense emotions can manifest in respiratory symptoms like shortness of breath and rapid breathing, as stress narrows the airways in the nose and lungs. Acute stress can trigger asthma attacks. Rapid breathing induced by stress may lead to panic attacks in some individuals [5].

Equally significant is the impact of stress on the digestive system. Nervous activation can lead to various gastrointestinal issues, from abdominal pain to irritable bowel syndrome. Long-term stress can also affect nutrient absorption and metabolism in the gastrointestinal tract. During stress, the liver produces glucose to provide energy. If someone is under chronic stress, his body may struggle to keep up with this extra surge in glucose. Chronic stress may increase the risk of developing type 2 diabetes [6].

1.2. The influence of stress on vision

When the body is stressed, cortisol and adrenaline levels increase. Experiencing cyclic anxious states results in a dangerous elevation of cortisol levels, disrupting the blood flow from the eye to the brain. This issue can lead to stress-related macular degeneration and optic neuropathy. Short-term changes in eye pressure may not necessarily be harmful, and people may not even notice them. However, prolonged changes in eye pressure can damage the optic nerve, contributing to the development of glaucoma. Adrenaline causes the dilation of the pupils to allow more light and facilitate the detection of potential threats. Continuous release of adrenaline leads to constant dilation of the pupils, causing strain of the eye muscles. Adrenaline can also increase pressure in the back of the eye, leading to blurred or tunnel vision symptoms [7].

Stress also affects the respiratory system and can impair one's ability to breathe. This can lead to decreased oxygen levels in the blood, resulting in low oxygen content in the eye blood vessels. Lack of oxygen in the retina can cause cell damage [7].

Stress can trigger the release of stress hormones such as cortisol, suppressing the immune system. Weakened immunity means the body is less capable of fighting infections, and the defense against cells that could lead to malignant changes in the eye or other parts of the body. Further it increases the risk of infectious eye diseases, such as conjunctivitis or keratitis, and inflammatory eye conditions, such as uveitis [8].

1.3. Stress and visual function

Several stress-related factors can significantly impact various aspects of visual functions and overall eye health [9]. One crucial aspect is accommodation and focus. The impact of stress on ocular accommodation is primarily mediated by the autonomic nervous system, especially the sympathetic and parasympathetic branches. Sympathetic nervous system activation leads to pupil dilation, enhancing distance vision. Prolonged activation may contribute to eye fatigue when focusing on close objects. Conversely, parasympathetic nervous system inhibition may contribute to eye fatigue and difficulty focusing on close objects. Stress often triggers muscle tension, particularly in the ciliary muscle, which is responsible for changing the eye's lens shape. It can lead to difficulties adjusting to changes in object distance, resulting in issues with image clarity and focus [10].

High stress can cause general muscle tension, including extraocular muscles. This can impact the stability of the eye apparatus and its ability to maintain optimal refraction. Also, the motility of eye muscles may be restricted [11].

Another critical area is pupil dilation. Stress can induce mydriasis, which is pupil dilation. This may affect the amount of light entering the eye and influence the perception of surrounding light and contrast. Pupil dilation and increased light sensitivity can lead to visual distortions. Flashes, flickering, or blurred vision are often associated with the influence of stress on pupils [12].

Dry eyes are another common phenomenon associated with stress. Insufficient blinking during stressful situations can reduce tear production, leading to eye dryness. Eye dryness can cause discomfort and blurred vision and affect visual functions [13].

Light sensitivity is another factor that can be influenced by stress. Some people may experience increased sensitivity to light, also known as photophobia, during stressful situations, causing discomfort when exposed to light [14].

Stress can also affect one's perception of the surrounding environment and contribute to changes in perceptual awareness. This change in perception can influence one's ability to interpret visual stimuli and impact overall concentration [15].

The interplay of stress on the eyes can result in various eye symptoms, including pain, fatigue, blurred vision, dryness, pulsating eyes, and many more. It is crucial to be aware of the psychophysical state and take adequate care of the eyes, especially during increased stress. Regular breaks, eye exercises, and moisturising can contribute to maintaining the health of the visual system during psychological pressure.

2. Method

2.1. Aim of the study

The methodology employs a longitudinal intervention approach, which allows for tracking changes over time, examining the effects of the intervention period, and evaluating long-term effects. The aim is to contribute to a deeper understanding of the relationship between stress and visual abilities and to explore whether stress reduction exercises can positively impact these areas.

2.2. Participants

The study involved 65 participants, eight dropping out due to non-compliance with the conditions. Among the participants who completed the measurements and adhered to the conditions, there were 57 individuals, including 27 males and 30 females. The average age was 27.1, with a standard deviation of ±8.8. The selection of participants was directed towards younger adults, who, according to the American Psychological Association [16], experience higher stress level than other generations.

2.3. Materials

The Perceived Stress Questionnaire (PSQ) by S. Levenstein [17], comprising 30 questions, was used to assess the stress level. Responses to these questions are based on experiences over the past two months. For each response, the respondent circles one of the options (almost, sometimes, often, or usually) based on the frequency of their stress-related experiences. The response "almost" is assigned a score of 1, "sometimes" 2, "often" 3, and "usually" 4. A higher score indicates a higher level of stress. The total score is obtained by summing each item (questions 1, 7, 10, 13, 17, 21, 25, and 29 are positively worded and scored in reverse). The PSQ index is calculated by subtracting 30 from the raw score and dividing the result by 90, resulting in a score between 0 and 1. The research-based questionnaire to assess visual problems contained 26 questions. The resulting index was calculated similarly to PSQ, subtracting the number of questions (26 in this case) from the raw score and dividing the result by 90, yielding a score between 0 and 1.

2.4. Procedure

In the initial phase of the study, a preliminary measurement was conducted using a questionnaire to gather information about the level of stress and visual difficulties among the participants. For a comprehensive view of the issue, participants were provided with a brochure titled "How to Manage and Reduce Stress," published by the Mental Health Foundation [18], which succinctly explains the concept of stress and offers activities for its reduction. The brochure also contributed to the initial motivation regarding the importance of stress reduction and participation in this study. Subsequently, we entered the intervention period, during which participants were offered various stress reduction exercises. These exercises included a range of relaxation techniques, meditation, breathing exercises, and much more. We specified the duration and frequency of these exercises (at least 20 minutes daily) and closely monitored participants and their activity during the two months. During these two months, eight participants dropped out of the study due to non-compliance with the exercise frequency. After the intervention period, a follow-up measurement was conducted using the same questionnaire as at the beginning of the study. We ensured that participants adhered to the requirements and rules of the intervention period. In the final phase of our methodology, a thorough quantitative analysis of questionnaire responses before and after the intervention period was conducted.

2.5. Analysis

Before the commencement of measurements, the following hypotheses were established.

1. The hypothesis addressed whether a higher stress level contributes to a higher level of eye problems.
   H0: There is a correlation between stress and eye problems.
   H1: There is no correlation between stress and eye problems.

2. The hypothesis addressed the change in stress levels before and after stress reduction exercises.

H0: Stress level before = Stress level after.
H1: Stress level before > Stress level after.

3. The hypothesis addressed the change in the level of eye problems before and after stress reduction exercises.

H0: Level of eye problems before = Level of eye problems after.
H1: Level of eye problems before > Level of eye problems after.

We utilised correlation analysis to assess the relationship between stress and eye problems before exercising. Specifically, we opted for Pearson's correlation coefficient as it assumes a linear relationship between variables and is sensitive to outliers, which is crucial for our data. Employing correlation analysis enables us to elucidate whether there is a statistically significant relationship between the variables under study.

Furthermore, we employed a one-sided paired t-test to compare the levels of stress and eye problems before and after exercise. This test is suitable for comparing two samples in cases where the data come from the same set of individuals, as in our case. Through this test, we can assess whether the change in stress level or eye problems is statistically significant.

3. Results

In the previous chapter, it was noted that 57 participants completed the study, comprising 27 males and 30 females. The average age was 27.1 with a standard deviation of ±8.8. Table 1 captures average index results with standard deviations from the Perceived Stress Questionnaire ("Stress level before", "Stress level after") and Visual Problems Questionnaire ("Level of eye problems before", "Level of eye problems after") before and after introducing stress reduction techniques into daily life.

Table 1. Results from questionnaires

	Average	Deviation
Stress level before	0.56	0.18
Stress level after	0.26	0.19
Level of eye problems before	0.22	0.13
Level of eye problems after	0.09	0.07

Data on the level of stress and eye problems before introducing stress reduction techniques were utilised to assess the relationship between stress and eye problems and evaluate the hypothesis. Pearson's correlation coefficient was employed for computation. The analysis results indicated that Pearson's correlation coefficient between the variables under investigation was 0.72, suggesting a significant positive correlation between them. This value is relatively high, indicating a strong association between the stress levels and the level of eye problems before introducing stress reduction techniques. Based on these findings, the alternative hypothesis, positing a correlation between stress and eye problems, can be accepted.

To accept the second hypothesis, whether the stress level after the introduction of stress reduction techniques will be lower than before, a one-sided paired t-test for means was used. The results are illustrated in Table 2.

Table 2. Stress level T-test result

	Before	After
Mean	0.556	0.263
Variance	0.031	0.014
Observations	57	57
Pearson Correlation	0.795	
Hypothesized Mean Difference	0	
df	56	
t Stat	20.16	
P(T<=t) one-tail	1E-27	
t Critical one-tail	1.673	
P(T<=t) two-tail	2E-27	
t Critical two-tail	2.003	

The null hypothesis (H0) stated that the stress level before exercising equals the stress level after exercising. Conversely, the alternative hypothesis (H1) proposed that the stress level before exercising is higher than after exercising. After statistical data analysis, the null hypothesis was rejected at the 5% significance level. This means a statistically significant difference exists between stress levels before and after exercise. This result reinforces the evidence supporting the alternative hypothesis, which suggested a higher stress level before exercising than after exercising. Rejecting the null hypothesis at the specified significance level indicates that the observed difference between the stress levels before and after exercising holds statistical significance.

To accept the third hypothesis that the level of eye problems will be lower after the introduction of stress reduction techniques, a one-sided paired t-test for means was used. The results are illustrated in Table 3.

Table 3. Level of eye problems T-test result

	Before	After
Mean	0.226	0.095
Variance	0.017	0.005
Observations	57	57
Pearson Correlation	0.799	
Hypothesized Mean Difference	0	
df	56	
t Stat	11.16	
P(T<=t) one-tail	4E-16	
t Critical one-tail	1.673	
P(T<=t) two-tail	7E-16	
t Critical two-tail	2.003	

The null hypothesis (H0) suggested that the level of eye problems before exercise equated to the level of eye problems after exercise. Conversely, the alternative hypothesis (H1) proposed that the level of eye problems before exercise exceeded that after exercise. Statistical data analysis invalidated the null hypothesis at the 5% significance level. This invalidation indicates a statistically noteworthy distinction between the level of eye problems before and after exercise. This outcome reinforces the backing for the alternative hypothesis, which conjectured a higher level of eye problems before exercise than after exercise. Rejecting the null hypothesis at the designated significance level implies that the observed contrast in eye problem levels is unlikely attributable solely to chance but holds statistical significance.

4. Conclusion

Stress affects vision in several ways. Alongside dilated pupils and increased eye pressure, people experiencing heightened stress may feel sensitivity to light, tunnel vision, dry or excessively moist eyes, blurred vision, eye fatigue, double vision, visual distortions, light flashes, foggy vision, reduced blinking frequency, seeing stars, shadowy vision, eye pulsations, and sore eye muscles. Objects may appear to move slightly, pulsate, or not be there at all. Additionally, there may be difficulties with focusing, limited eye mobility, and eye twitching.

It is essential to be aware that each person responds to stress individually and thus may have different impacts on health. Stress prevention and ensuring overall mental and physical health can be crucial for minimising risks associated with eye conditions. Regular eye examinations and a healthy lifestyle can contribute to maintaining optimal eye health.

This study has provided valuable insights into the intricate relationship between stress and visual health, as well as the potential efficacy of stress reduction exercises in mitigating visual problems. Through a longitudinal intervention study involving 57 participants, significant findings were obtained.

Firstly, our analysis revealed a strong positive correlation between stress levels and the prevalence of visual problems among participants before engaging in stress reduction exercises, aligning with previous research. Individuals with higher stress levels also had a higher degree of visual problems. Conversely, individuals with lower levels of stress did not experience visual discomfort. This underscores the multifaceted impact of stress on ocular health, implicating both physiological and psychosocial mechanisms.

Secondly, following a two-month intervention period involving stress reduction exercises, there was a notable reduction in stress levels and visual problems among participants. Statistical analysis indicated significant decreases in perceived stress and visual problems scores, suggesting tangible benefits in stress management and visual health through engagement in stress reduction exercises.

These findings have important implications for theory and practice. The study contributes to a deeper understanding of the biopsychosocial mechanisms underlying the stress-visual health relationship, emphasising the importance of holistic health promotion strategies that address both psychological well-being and physical health. Practically, integrating stress reduction techniques into vision care programs offers a promising avenue for enhancing ocular health and reducing the burden of visual impairments.

However, it is essential to acknowledge the limitations of this study, including reliance on self-report measures and a predominantly young adult sample, which may limit generalizability. Future research should employ objective measures and replicate the study with more diverse samples to enhance external validity.

Moving forward, further investigation into the long-term effects of stress reduction interventions on visual health outcomes and identifying of optimal strategies for promoting ocular health in stress-prone populations are warranted. By addressing these research gaps, we can continue to advance our understanding and enhance interventions to optimise visual health in individuals facing stress-related challenges.

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Appendix A.

A.1. Perceived stress questionnaire

Perceived stress questionnaire

	Almost	Sometimes	Often	Usually
1. You feel rested	1	2	3	4
2. You feel that too many demands are being made on you	1	2	3	4
3. You are irritable or grouchy	1	2	3	4
4. You have too many things to do	1	2	3	4
5. You feel lonely or isolated	1	2	3	4
6. You find yourself in situations of conflict	1	2	3	4
7. You feel you are doing things you really like	1	2	3	4
8. You feel tired	1	2	3	4
9. You feel you may not manage to attain your goals	1	2	3	4
10. You feel calm	1	2	3	4
11. You have too many decisions to make	1	2	3	4
12. You feel frustrated	1	2	3	4
13. You are full of energy	1	2	3	4
14. You feel tense	1	2	3	4
15. Your problems seem to be piling up	1	2	3	4
16. You feel you are in a hurry	1	2	3	4
17. You feel safe and protected	1	2	3	4
18. You have many worries	1	2	3	4
19. You are under pressure from other people	1	2	3	4
20. You feel discouraged	1	2	3	4
21. You enjoy yourself	1	2	3	4
22. You are afraid for the future	1	2	3	4
23. You feel you are doing things because you have to not because you want to	1	2	3	4
24. You feel criticised or judged	1	2	3	4
25. You are lighthearted	1	2	3	4
26. You feel mentally exhausted	1	2	3	4
27. You have trouble relaxing	1	2	3	4
28. You feel loaded down with responsibility	1	2	3	4
29. You have enough time for yourself	1	2	3	4
30. You feel under pressure from deadlines	1	2	3	4

Appendix B.

B.1. Visual problems questionnaire

Visual problems questionnaire

	Almost	Sometimes	Often	Usually
1. You have dilated pupils	1	2	3	4
2. You have blurred vision	1	2	3	4
3. You experience tunnel vision	1	2	3	4
4. You feel sensitive to light	1	2	3	4
5. You feel pulsating in your eyes	1	2	3	4
6. You suffer from dry or, conversely, moist eyes	1	2	3	4
7. You feel eye fatigue	1	2	3	4
8. You experience double vision	1	2	3	4
9. You feel distortion in the objects you are looking at	1	2	3	4
10. You feel flashes of light when observing an object	1	2	3	4
11. You experience vision fogging	1	2	3	4
12. You notice a decrease in blinking frequency	1	2	3	4
13. You see stars when focusing on an object	1	2	3	4
14. You see shadows/ghosts when focusing on an object	1	2	3	4
15. You feel eye muscle pain	1	2	3	4
16. You see a stationary object moving when you look at it	1	2	3	4
17. You see things that are not there	1	2	3	4
18. You have difficulty focusing on distant objects	1	2	3	4
19. You have difficulty focusing on close objects	1	2	3	4
20. You feel limited eye movement when looking sideways	1	2	3	4
21. You experience eyelid twitches	1	2	3	4
22. You suffer from eye infection and inflammations	1	2	3	4
23. You experience rapid fatigue when reading or working up close	1	2	3	4
24. You experience decreased concentration when reading or working up close	1	2	3	4
25. You experience eye discomfort when working up close (burning, tearing, etc.)	1	2	3	4
26. You feel eye pain	1	2	3	4