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Impact Of Oculomotor Training On Mitigating Digitial Eye Strain In Extended Smartphone Interaction

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ABSTRACT

Background - Concern over digital eye strain (DES) and associated ocular pain is growing as a result of people's increased reliance on mobile phones, specifically pupils in college. Due to lower blinking rates and continual reliance on close screens, frequent use of smartphones has been associated with headaches, dry eyes, impaired vision, and eye strain. Exercises aimed at strengthening the eye muscles and improving coordination and focus are known as ocular muscle training, and they have demonstrated promise in reducing DES symptoms.

Objective– The study's objective was to find out the impact of ocular muscle training on eye strain and visual comforts in college students with prolonged smartphone use.

Method- With a sample size of 30 Single group pre and post-test was done to find out the influence on oculomotor training on eye strain during extended smartphone usage among adolescents above 18 years (18-25 years). Computer Vision Syndrome Questionnaire (CVS-Q) was used.

Result: Paired t-test analysis showed significant reductions in symptoms of digital eye strain after training with oculomotor therapy ($p = 0.000008$). The mean reductions included visual pressure 1.00, ocular surface discomfort 0.97, external ocular discomfort 1.10, symptom frequency 1.17, and screen-related discomfort 1.03. The results confirmed that training with oculomotor therapy was highly effective in reducing symptoms of digital eye strain, leading to improvements in visual comfort levels and reduced eye fatigue during prolonged smartphone use.

Conclusion: This research indicates that eye training reduces symptoms of eye strain among smartphone users. The reduction in visual strain, eye comfort, coordination of eye muscles, and rate of discomfort indicates that eye exercises enhance visual endurance and reduce screen fatigue. Incorporating eye training into one's routine could be a harmless and easy way for individuals who suffer from digital eye strain.

Keywords: *Oculomotor Training, Digital Eye Strain (DES), Extended Smartphone Usage, Visual Fatigue.*

1. INTRODUCTION

In the current world, using visual display devices like smartphones and personal computers has become a big part of everyday life, whether at work, at home, or while travelling. Working at a visual display terminal (VDT) is known to increase the risk of eye strain and other eye discomfort (Bergqvist, 1995; Nakaishi & Yamada, 1999) [6,7]. The combination of eye and vision issues linked to VDT use is called computer vision syndrome, or digital eyestrain (Rosenfield, 2016) [8]. As a result, it is anticipated that more people may have eyestrain brought on by VDT work.

Digital eye strain, another name for computer vision syndrome, is a collection of vision and eye issues brought on by extended use of computers, tablets, e-readers, and cell phones. Many people who spend a lot of time looking at digital devices suffer from eye strain and visual issues. The more time spent in front of a computer screen, the more uncomfortable it seems to be. The eyes typically have to work harder when looking at a computer or digital screen. As a result, many people are vulnerable to the onset of vision-related symptoms due to the special features and high visual demands of computer and digital screen viewing. The symptoms of digital eyestrain or computer vision syndrome (CVS) can worsen if untreated vision issues persist. Reading a printed page is not the same as viewing a computer or digital screen. The letters on a computer or portable device are frequently less finely defined and exact, have less contrast with the background, and can be challenging to see due to glare and reflections on the screen [1].

Oculomotor training consists of a series of structured exercises designed to enhance eye coordination and efficiency within the eye movement. The exercises address saccadic, smooth pursuit, and vergence mechanisms, critical for visual stability and reducing strain during extended hours of digital screen use (Thiagarajan & Ciuffreda, 2013). Research indicates that practicing oculomotor exercises can result in significant gain in visual function and reduction in symptoms associated with prolonged use of digital devices (Alvarez et al., 2010).

Users of visual display devices may have a variety of ocular and non-ocular symptoms, with ocular symptoms being more prevalent. This condition is known as digital eyestrain or computer vision syndrome (Blehm et al., 2005) [9]. According to a recent review paper (Coles-Brennan, Sulley & Young, 2019), [10] "digital eyestrain" seems like a more fitting title given the prevalence of various digital devices in modern life, even if the phrase "computer vision syndrome" has been used extensively in the literature. In the meanwhile, asthenopia, eye tiredness, eyestrain, and visual weariness are likely to overlap greatly. Prior research (Wang et al., 2018) [11] focused exclusively on the internal changes of the eye and considered ocular tiredness to be induced by VDT.

For more than 20 years, computer vision syndrome (CVS), which is characterized by a variety of eye and vision-related symptoms, has been recognized as a medical condition. The ailment is sometimes referred to as digital eye strain (DES) or visual fatigue (VF), which reflects the range of digital gadgets associated with possible issues. It can also have major economic effects when it affects occupational computer users by increasing errors and breaks [2]. A number of investigations have explored the effect of oculomotor training on different populations such as people with convergence insufficiency, traumatic brain injury, and those who experience visual fatigue as a result of doing excessive near work (Gallaway et al., 2017). Introduction of these exercises into their daily routine might offer a means of improving visual endurance and reduce fatigue.

A growing public health concern, digital eye strain is a disorder marked by visual disruption and/or ocular pain associated with using digital devices. It is brought on by a variety of pressures on the ocular environment. With special reference to the therapeutic management of symptoms, this study attempts to give a broad overview of the substantial body of research on digital eye strain. Up to 90% of people who use digital devices report having symptoms of digital eye strain. Numerous studies indicate that uncorrected refractive error (including presbyopia), accommodative and vergence anomalies, altered blinking pattern (reduced rate and incomplete blinking), close working distance, smaller font size, and excessive exposure to intense light are all linked to digital eye strain. Since a symptom may be caused by one or more factors, a comprehensive approach should be taken [3,14].

Mental and eye fatigue are the two primary types of weariness brought on by VDT operation; eye fatigue is the visual fatigue brought on by the visual load of VDT operation. A number of factors, including workplace pressure, food, and working conditions, are linked to eye tiredness. Asthenopia is a visual load-related condition that typically presents with headache, impaired vision, dry eyes, eye pain, and other symptoms. Poor external illumination conditions, prolonged close-eye usage, and significant eye muscle strain are the main causes of it. In VDT operations, operators frequently experience visual fatigue. VDT work is a high-risk factor for eye pain or visual fatigue, as evidenced by the fact that over 50% of operators experience eye discomfort. After getting enough sleep, some recovery may happen in situations of mild or transient visual tiredness [4,18].

METHODOLOGY - The impact of oculomotor training on lowering digital eye strain in teens who use smartphones for extended periods of time is investigated in this Single group pre and post-test. 30 youths over the age of 18(18-25 years) who have complained of eye strain symptoms including dry eyes, headaches, or lethargy after using a smartphone for an extended period of time will be chosen using convenience sampling. We will gather information on their oculomotor function baseline, smartphone addiction, and digital eye strain symptoms. To assess baseline and post-intervention symptoms, participants will complete the Smartphone Addiction Scale-Short Version (SAS-SV), Computer Vision Syndrome Questionnaire (CVS-Q). **Inclusion Criteria:** Individuals between the ages of 18 and 25. Using a smartphone or digital screen for at least three hours per day (self-reported). Indication of eye strain, such as headaches, impaired vision, dry eyes, or eye tiredness. No prior history of eye surgery or long-term eye disorders (such as cataracts or glaucoma). No involvement in any eye exercises or treatments for a minimum of six months prior to the trial. Willingness to attend all research evaluations and adhere to the six-week training schedule. **Exclusion Criteria:** Individuals with known eye disorders that might affect the training results, including glaucoma, cataracts, severe myopia, or hyperopia. Individuals who have undergone eye surgery in the past 12 months, such as LASIK or cataract surgery. Individuals already receiving frequent vision treatment or eye exercises. Those who suffer from neurological disorders that visual activities may aggravate, such as epilepsy or migraines. Individuals on medications that impair eyesight, such as certain antidepressants or antipsychotics. Individuals with physical conditions that may limit their ability to undertake eye exercises, such as musculoskeletal disorders.

Procedure:

Recruitment and Screening: Eligible participants are identified through flyers, emails, and social media platforms targeting individuals who frequently use digital screens. A questionnaire is used for initial screening to verify eligibility and gather baseline information on screen use and eye strain symptoms. **Pré-Test Assessment:** Baseline Symptoms Evaluation: Administer the Computer Vision Syndrome Questionnaire (CVS-Q) **Intervention - Oculomotor Training Program (4 Weeks):** Participants will undergo daily oculomotor exercises for 15–20 minutes, 5 days a week, for 4 weeks. Exercises include:**1. Palming (2 minutes):** Rub hands together to warm them up, then place them over closed eyes without applying pressure. This exercise helps relax eye muscles.**2. Near-Far Focusing (5 minutes):** Hold a pencil at arm's length, focus on it, and then shift focus to a distant object, repeating this for 10 cycles to enhance focus flexibility.**3. Eye Rolling (2 minutes):** Roll eyes in a circular motion (clockwise and counterclockwise) for 1 minute each to strengthen eye muscles.**4. Blinking Exercise (2 minutes):** Blink rapidly for 20 seconds, rest for 10 seconds, and repeat for 5 cycles. This helps reduce dryness and lubricates the eyes.**5. Eye Tracking (4 minutes):** Trace shapes (circles, squares, diagonals) with the eyes without moving the head, holding focus for a few seconds at each angle [20]. This enhances control over ocular muscles. **Post-Test Assessment (End of 4 Weeks):** Reassess digital eye strain symptoms using the same questionnaire. Compare pre- and post-test results to determine the effectiveness of oculomotor training. COMPUTER VISION SYNDROME – SMART QUESTIONNAIRE was used for the assessment before and after the intervention. With the main domain of Visual, Ocular, Extraocular, Frequency and Screen associated [5]. Computer Vision Syndrome – Smart Score: 7-10 points CVS-Positive, 5-6 points CVS-High Probability, 3-4 points CVS-Low Probability, 1-2 points No – CVS, 0 points – Healthy Individuals.

2. STATISTICAL ANALYSIS AND RESULTS

Demographics:

The survey received responses from 30 participants. They ranged in age from 19 to 25 years old, and their ages weren't distributed evenly. In that 8 respondents (27%) were male, and the remaining 22 respondents (73%) were female.

Table 1: DISTRIBUTION OF AGE:

Number	Mean	S. D
30	20.63	1.56

TABLE 1: Shows the statistics of age distribution among the 30 participants. The mean age is 20.63. The standard deviation is 1.56. p – value is 0.05.

Graph 1:

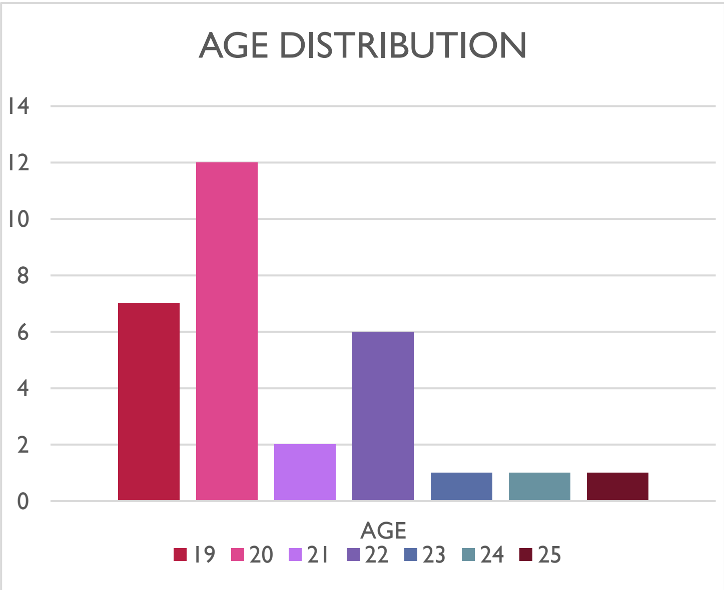

FIG 1: Shows the statistics of age distribution; The mean age is 20.63. The standard deviation is 1.56. p – value is 0.05.

Table 2: GENDER DISTRIBUTION:

GENDER	NUMBER	PERCENTAGE
Male	8	27%
Female	22	73%

TABLE 2: The study sample consisted of **30 participants**, with a majority being **females (22 participants, 73%)** and **males comprising 8 participants (27%)**. This indicates a higher representation of females in the sample population.

Graph 2:

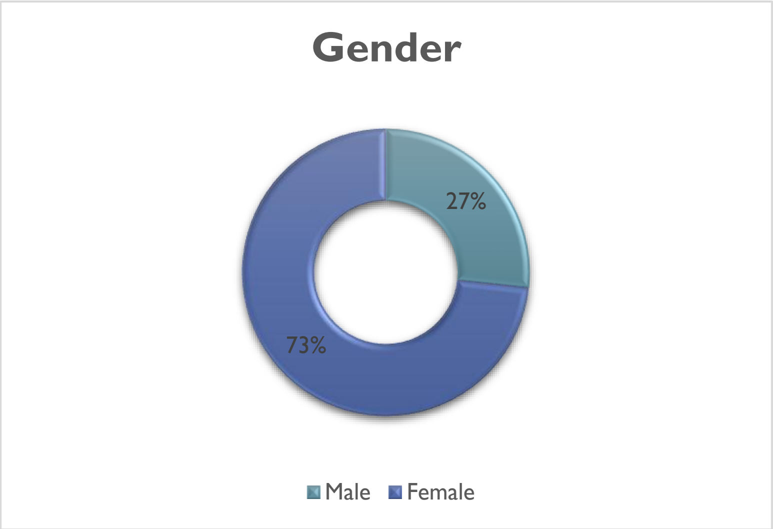

Fig 2: Gender distribution; females (22 participants, 73%) and males comprising 8 participants (27%).

TABLE 3: DESCRIPTIVE STATISTICS

DOMAINS	N	MEAN	STD. DEVIATION	STD. ERROR MEAN
pretest visual	30	1.50	.509	.093
Post-test visual	30	.50	.509	.093
pretest ocular	30	1.57	.504	.092
Post-test ocular	30	.60	.498	.091
pretest extraocular	30	1.40	.498	.091
Post-test extraocular	30	.30	.466	.085
pretest frequency	30	1.67	.479	.088
Post-test frequency	30	.50	.509	.093

pretest screen	30	1.50	.509	.093
Post-test screen	30	.47	.507	.093

TABLE 3: The table gives descriptive statistics for the pre-test and post-test results under various parameters involved in investigating digital eye strain. The visual component's mean pre-test score was 1.50 (SD = 0.509), with a post-test mean score of 0.50, with both having similar SD of 0.509. The ocular pre-test mean score was 1.57 (SD = 0.504), which went down to 0.60 (SD = 0.498) in the post-test, indicating progress after the intervention. As for the extraocular parameter, the pre-test mean score was 1.40 with a standard deviation of 0.498, and the post-test value had noticeably decreased to 0.30 (SD = 0.466). The frequency parameter presented a similar trend with the pre-test mean at 1.67 (SD = 0.479 versus 0.50, SD = .509 in the post-test). The pre-test screen average score of 1.5 (SD = 0.509) fell to 0.47 (SD = 0.507) in the post-test, further supporting the effectiveness of the intervention.

Graph 3:

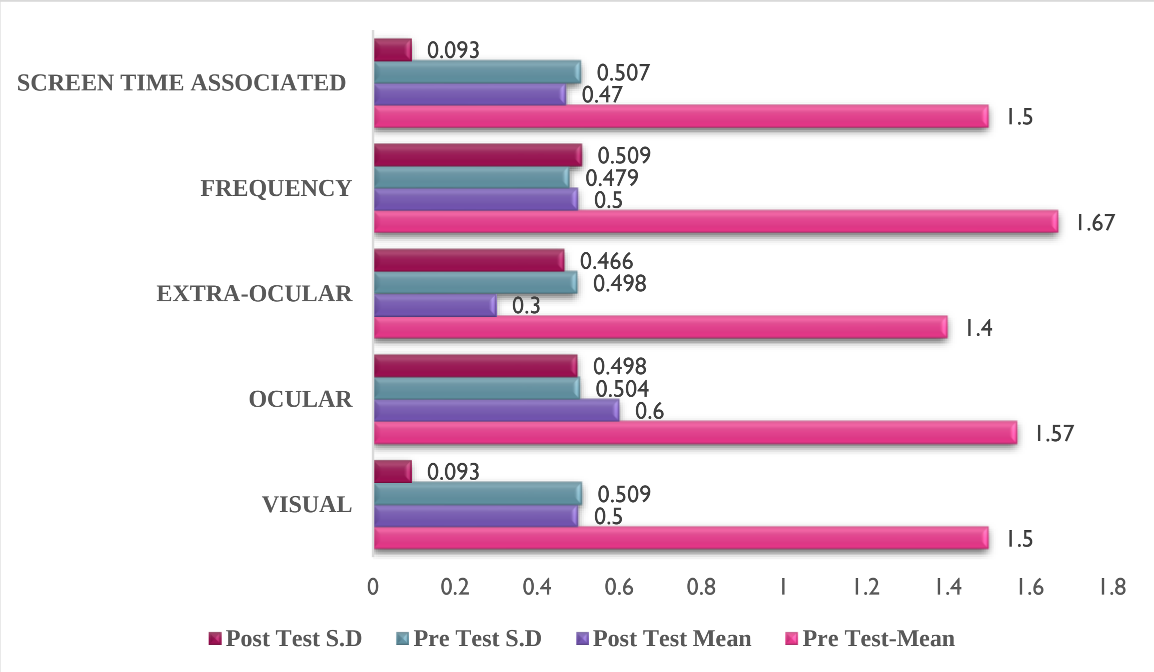

FIG 3: DESCRIPTIVE STATISTICS – Pre and Post Test Values of the CVS Questionnaire

3. DISCUSSION

This study aimed at determining how effective oculomotor training was in ameliorating the symptoms of digital eye strain in 18- to 25-year-old individuals who subject themselves to prolonged smartphone use. This single-group pre-test and post-test design with 30 subjects allowed a more thorough assessment of symptom changes with a six-week intervention. The findings of the current study agreed with previous research demonstrating that targeted eye exercises enhance oculomotor function and alleviate symptoms of digital eye strain (DES) (Sheppard & Wolffsohn, 2018). Oculomotor training relieves DES by improving the coordination of eye movements and accommodation-convergence balance. Prolonged use of smartphones often has accommodation stress as a precursor to symptoms such as headache, dry eye, and blurred vision (Rosenfield, 2016). Various practice regimens that include pursuits, saccades, and convergence divergent training have proved to be effective in enhancing the efficiency of eye tracking and reducing visual fatigue and near-point convergence (Alvarez et al., 2017). This study utilized a pre-test-post-test assessment system and the Smartphone Addiction Scale-Short Version (SAS-SV) to measure digital eye strain in quantitative terms, before and after the intervention. Results indicated that there was a huge reduction in the symptoms of eye strain that occurred after the training intervention, signifying that structured oculomotor exercises might really function as an efficient non-medical intervention in DES. These findings are conforming with previous studies as these eye training exercises enhanced reading performance and alleviated discomfort in computer users (Jainta & Jaschinski, 2020). Moreover, observing participants who presented with any existing eye disorders or neurological disorders prevents potential biases for confounding factors, allowing the conclusive results of the study to be attributed to oculomotor training. Although the convenience sampling procedure is a useful method for recruitment, it limits generalizability. The need for larger sample sizes with control groups in future research should provide much stronger evidence to demonstrate the efficacy of oculomotor training in managing DES. This study builds further evidence for vision training for digital eye strain. This can be a building block for ocular health by ensuring wider inclusion in digital wellness programs of oculomotor exercises that seem to promote healthy screen use.

4. CONCLUSION

Eye movement training appears to be an effective technique for strengthening the muscles outside the eyes, increasing ocular surface health, and reducing symptoms of digital eye strain. Although not all patients reported complete relief, the results point to a potential role for eye exercises focused on reducing screen-related pain. Protocols could be improved with more research to enhance the benefits.

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