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EFFECTIVENESS OF GUIDED EYE EXERCISES IN REDUCING DIGITAL EYE STRAIN AND VISION-RELATED SYMPTOMS IN YOUNG ADULTS

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ABSTRACT

BACKGROUND: The long usage of digital screens has caused the eye-related issues to become significantly apparent among young adults. Such common symptoms are visual fatigue, dryness, and lack of focus. Guided eye exercises are being considered as a viable way of alleviating such problems as digital use increases. The paper is intended to determine their efficacy in decreasing their screen time-related discomfort.

OBJECTIVE: To determine the effect of a formal eye exercise training program in reducing digital eye strain symptoms (eye fatiguing, pressure headache and blurred vision) among young adults who spend a substantial amount of time at a screen.

MATERIAL AND METHODS: A randomized controlled trial was carried out at Azhar Health Care Complex, Lahore for six months. A total 114 participants aged between 18-35 years were recruited through simple random sampling and given a structured eye exercise intervention to treat the symptoms of digital eye strain.

RESULTS: One hundred and forty-four people were involved in the study and the mean age was 25.31 2.70 years and 58(50.9) were females and 56(349.1) were males. Post-intervention analysis revealed a statistically significant decline in symptoms of digital eye strain ($p < 0.001$), with the intervention group showing greater improvement than the control group ($p = 0.004$). Most participants consistently followed the exercise routine, and the majority reported noticeable relief in symptoms.

CONCLUSION: Guided eye exercises significantly reduced digital eye strain symptoms among young adults, especially with consistent practice. The intervention proved to be a practical, low-cost solution with strong participant adherence and positive outcomes.

KEYWORDS Eyestrain, Blinking, Eye fatigue, Screen time

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INTRODUCTION

In today's fast-paced world, the need for near and intermediate visual tasks, including prolonged computer use, reading, and gazette work, has dramatically increased. This requires continuous engagement of the extraocular muscles (vergence) and ciliary muscles (accommodation), leading to excessive strain. The overworking of these muscles can result in eye fatigue, which is a common issue in individuals engaged in prolonged near tasks. As a consequence, eye fatigue often leads to various associated asthenopic symptoms such as discomfort, headaches, and blurred vision [1]. Digital eye strain is a phenomenon linked to ever increasing digital screen use globally, affecting a large number of individuals [2].

Eye fatigue is a common complaint due to computer usage for academic or recreational purposes or social networking. Generally, eye fatigue can be developed by factors including insufficient lighting, prolonged watching of visual displays, poor diet, eye muscle insufficiency due to prolonged hours of office work and academic studies, psychological and emotional tension and ageing [3].

Just like any other muscle in the body, the muscles involved in vision, particularly the extraocular muscles, need regular exercise to maintain their health. Yogic exercises can effectively strengthen these muscles, helping to prevent eye strain. If visual fatigue persists in daily life, it can impair visual processing, leading to decreased visual acuity, ocular discomfort, and potential damage to the corneal epithelial cells. Prolonged visual fatigue also negatively affects the processing of visual signals, disrupting the connection between the vestibular organ system and the somatosensory network. This disruption can further impact the body's postural control systems, leading to broader physical consequences [4].

Implementing the Eye exercise needs a social awareness and particular assistance to the therapy. This vision therapy is an option for people whose blurred distance vision is caused by a spasm of the muscles that control eye focusing i.e. ciliary muscles. Various eye exercises can improve poor eye focusing ability and regain clear vision. Hence, there is the need to advise a eye exercises. Especially in this era of technology there is increased usage of screens. Focusing time on small screens has considerably increased [5].

Digital eye strain has a multifactorial pathophysiology, influenced by factors like reduced contrast on screens, glare, improper viewing distance, poor lighting, and incorrect posture. The eye's accommodation and convergence mechanisms are taxed during screen use, making individuals with uncorrected or under-corrected refractive errors more vulnerable. Symptoms include eyestrain, headaches, dry or irritated eyes, blurred vision, and double vision [6].

Visual display terminals have become an integral part of our daily lives. Collectively referred to as digital devices, smartphones, tablets, electronic book readers, and computers have significantly increased in recent years and resulted in several ocular and visual symptoms related to their use, conjointly now known as digital eye strain [7]. Electronic devices emit high-energy short-wave currents that can penetrate the eye, potentially leading to photochemical damage to retinal cells. This damage can contribute to various eye issues, ranging from dry eye and eye fatigue to age-related macular degeneration. Eye fatigue manifests clinically with symptoms such as throbbing or pain around the eyes, double vision, blurred vision, difficulty focusing, sore or watery eyes, redness, and headaches. In some cases, it is accompanied by nausea, body aches, and heightened emotional sensitivity [8].

Extended use of digital screens can result in a combination of physical and visual discomfort that interferes with daily functioning. As screen-based activities become more prevalent, especially in work and leisure settings, it is important to recognize and address the associated visual health challenges. Taking steps to reduce screen time, incorporating regular breaks, and maintaining proper ergonomics are essential strategies for minimizing the risk of digital eyestrain and promoting long-term eye comfort [9]. The global surge in screen-based activities has turned digital eye strain into a pressing public health issue. Without proper screen habits and preventive care, prolonged exposure to digital devices can lead to lasting discomfort and reduced visual performance. It is essential to raise awareness about healthy screen use, adopt protective practices—such as the 20-20-20 rule—and ensure ergonomic setups to help reduce the burden of CVS in our increasingly connected world [10].

The growing reliance on smartphones reflects not only technological progress but also a transformation in how people communicate, learn, and access information. With usage increasing steadily across various populations, smartphones have become an integral part of daily life. Their expanding presence underscores the need to better understand the social, educational, and health implications of prolonged and frequent smartphone interaction in today’s digital age [11]. The extensive and growing dependence on digital screens underscores a global health concern. As screen-based tasks become more embedded in daily routines, the risk of vision-related issues like digital eye strain increases substantially. These findings emphasize the urgent need for preventive strategies, public awareness, and responsible screen usage practices to protect visual health in a technology-driven world [12].

Smartphones are advanced digital tools equipped with numerous features, allowing users to access social media platforms, online games, and various forms of entertainment. For learners, especially those in academic settings, smartphones have become essential devices that support educational activities. They offer convenient access to study materials anytime and anywhere, and their user-friendly interfaces, along with a wide array of free, accessible features, help enhance student engagement and interaction in the learning process. Despite these benefits, prolonged smartphone use can negatively affect users’ physical well-being. One of the most concerning health issues related to excessive screen time is digital eye strain (DES)—a condition often referred to as visual fatigue, which results from continuous focus on small digital screens during learning activities [13].

Computer Vision Syndrome (CVS) has emerged as a significant global health issue and is widely recognized as one of the most common work-related health problems of the 21st century. It is estimated that over 70% of individuals who regularly use computers are affected, with approximately 60 million people worldwide experiencing symptoms. Each year, nearly one million new cases are reported. This condition leads to reduced efficiency at work, diminished job satisfaction, increased chances of errors, and impaired visual performance. The situation is particularly concerning in low-income regions, where limited access to ergonomic equipment, insufficient use of protective tools, excessive workload, and lack of scheduled breaks further intensify the impact of CVS. These

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challenges make prevention and intervention efforts more difficult, highlighting the urgent need for awareness and practical solutions in under-resourced settings [14].

METHODOLOGY

This randomized controlled trial (RCT) was conducted at Azhar Health Care Complex, Lahore, over a period of six months following BASR approval. A total of 114 participants aged 18–35 years were recruited using simple random sampling, with the sample size calculated via G*Power (version 3.1.9.7) based on a 95% confidence level, 80% power, effect size of 0.5, and a 10% dropout allowance. Eligible participants included male and female digital device users experiencing symptoms of digital eye strain, while individuals with ocular/systemic diseases, high ametropia, prior ocular surgery, or ongoing vision therapy were excluded. Participants were randomly allocated into intervention and control groups using an online randomizer, and a single-blind design was maintained to reduce bias. The intervention group performed a structured eye exercise program, whereas the control group continued routine screen use without intervention. Data were collected using demographic questionnaires, symptom severity scales (0–10), and the Visual Analogue Scale for Fatigue (VAS-F) at baseline and post-intervention. Ethical standards were strictly followed, with informed consent, confidentiality, anonymity, and voluntary participation ensured. Data analysis was carried out using SPSS version 27, with normality assessed by the Shapiro–Wilk test; within-group comparisons were performed using the Wilcoxon signed-rank test and between-group comparisons using the Mann–Whitney U test.

RESULTS

In this study, a total of 114 participants were enrolled, of whom 58(50.9%) were females and 56(349.1%) were males. The average age in this study was 25.31±2.70 years, ranging from 20-30 years. the normality of data was assessed through the Shapiro-Wilk test. Results indicated that data were not normally distributed (P <0.05).
The devices used by participants revealed that the majority relied mainly on smartphones for their digital activities. Specifically, 72 participants (63.16%) reported smartphones as their main device, highlighting a strong preference and potential overexposure to small-screen use. In contrast, laptops, tablets, and desktop computers were each reported as the primary device by 14 participants (12.28% each), as shown in Figure 1.

Table No. 1: Comparison of Pre- and Post-Intervention Symptom Scores

Symptom	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	Wilcoxon Z	p-value
Eye strain	7.89 ± 1.03	3.76 ± 0.72	-9.302	<0.001
Blurred vision	7.85 ± 0.99	3.70 ± 0.74	-9.294	<0.001
Dry eye	7.93 ± 0.74	3.61 ± 0.68	-9.368	<0.001
Headache	7.89 ± 0.75	3.56 ± 0.81	-9.368	<0.001
Neck/shoulder pain (n=57)	7.87 ± 0.95	3.56 ± 0.87	-6.610	<0.001

Symptom severity was assessed on a numeric scale ranging from 0 (none) to 10 (severe). Before the intervention, participants reported relatively high severity across all symptoms, with mean scores between 7.85 and 7.93, indicating moderate to severe symptom levels. Specifically, eye strain had a mean severity of 7.89, blurred vision 7.85, dry eye 7.93, headache 7.89, and neck/shoulder pain 7.87. Following the guided eye exercise program, there was a significant reduction in symptom severity, with mean post-intervention scores ranging from 3.56 to 3.76, reflecting mild symptom levels on the 0–10 scale. The Wilcoxon signed-rank test revealed these reductions were statistically significant for all symptoms ($p < 0.001$). The consistent reduction across all symptom suggests that the guided eye exercises were effective in alleviating digital eye strain and related symptoms among young adults who use screens for prolonged periods.

Table No. 2: Comparison of Post-Intervention Symptom Scores Between Groups

Groups	N	Mean Rank	Mann-Whitney U test	P-value
Intervention	57	66.21	1128.0	0.004
Control	57	48.79		
Total	114			

The intervention group (n = 57) had a significantly higher mean rank (66.21) compared to the control group (mean rank = 48.79), indicating lower symptom severity in the intervention group. The difference between groups was statistically significant, (p = 0.004). This suggests that participants who followed the guided eye exercise regimen experienced significantly greater reductions in digital eye strain symptoms compared to those in the control group.
To assess adherence to the guided eye exercise program, participants were asked how often they performed the prescribed exercises during the intervention period. The majority of participants, out of 114, 82(71.93%), reported that they often followed the exercise routine. Additionally, 23 participants (20.18%) indicated that they always followed to the exercises, while only 9 participants (7.89%) reported performing the exercises rarely. These results suggest a high level of engagement with the intervention, with over 92% of participants reporting either regular or consistent participation.

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Table No. 3: Regularly Performed Eye Exercises by Participants

Exercise	Frequency	Percentage
20-20-20 Rule	20	17.5
Blinking exercises	24	21.1
Focus shifting (near and far focus)	17	14.9
Palming	14	12.3
Eye rolls	16	14.0
Pencil push-ups	12	10.5
Diagonal eye movements	11	9.6
Total	114	100.0

The most frequently performed exercise was blinking exercises, reported by 24(21.1%) participants. This was followed by the 20-20-20 rule practiced by 20 participants (17.5%), and focus shifting between near and far objects by 17(14.9%) participants. Other commonly used techniques included eye rolls (14.0%), palming (12.3%), and pencil push-ups (10.5%). The least commonly practiced was diagonal eye movements, reported by only 11 participants (9.6%). These findings suggest that participants tended to prefer simpler or more familiar exercises, such as blinking and the 20-20-20 rule, which may be easier to remember and incorporate into daily routines.

Table No. 4: Participant Feedback on Eye Exercise Intervention

Questions	No. of Responses	Percentages
How many times per day did you perform the exercises?		
Once	14	12.3
Twice	64	56.1
Three Times	36	31.6
Did you notice any improvement in your symptoms after the intervention?		
Significant improvement	16	14.0
Moderate improvement	68	59.6
Minimal improvement	30	26.3
Do you believe eye exercises can alleviate digital eye strain?		
Strongly Agree	32	28.1
Agree	70	61.4
Neutral	12	10.5
Did you notice an improvement in your symptoms during the study?		
Significant improvement	66	57.9
Moderate improvement	42	36.8
No change	6	5.3

Participant responses revealed important insights into their behaviour, perceptions, and experiences with the guided eye exercise program. When asked about the frequency of exercise practice, a majority of participants (64 out of 114; 56.1%) stated performing the exercises twice daily, while 36(31.6%) participants performed them three times daily, and only 14 participants (12.3%) did the exercises once per day. This indicates a high level of commitment among participants to follow the prescribed regimen multiple times a day.

In terms of perceived effectiveness, following the intervention, most participants (68; 59.6%) reported moderate improvement in their symptoms, while 16 (14.0%) experienced significant improvement, and 30 (26.3%) noted minimal improvement. Furthermore, when asked if they noticed improvement during the study itself, 66(57.9%) participants reported significant improvement, and 42 (36.8%) reported moderate improvement, with only 6 participants (5.3%) observing no change.

All participants confirmed that they had heard of eye exercises before participating in the study, indicating prior awareness of non-pharmacological approaches to digital eye strain. Additionally, belief in the effectiveness of eye exercises was strong: 70 participants (61.4%) agreed, and 32 (28.1%) strongly agreed that such exercises could alleviate digital eye strain, while only 12 (10.5%) remained neutral.

DISCUSSION

In the digital era, young adults are spending more time in digital screens, that have caused the rising incidence of digital eye strain (DES). DES is a set of symptoms connected with the long-duration use of digital devices, like smartphones, tablets, and computers, which include eye fatigue, blurred vision, dryness, headaches, and neck or shoulder pain [15]. This study investigated the potential of a guided program comprising eye exercises in reducing such symptoms in people aged 20 to 30 years. There were 114 participants (mean age 25.31 ± 2.70 years; 50.9% female), evaluated in terms of the symptoms pre- and post-intervention. The results showed

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significant symptomatic improvement, as post-intervention scores have decreased remarkably in every category used compared to the baseline, which is a strong addition to non-pharmacologic approaches to DES management.

The participants had symptom scores that were in the moderately severe range that included eye strain (7.89 ± 1.03), blurred vision (7.85 ± 0.99), dry eyes (7.93 0.74), headache (7.89 0.75), and neck/shoulder pain (7.87 0.95) at the baseline. These high scores correspond to the Digital Eye Stain Comprehensive Survey (2022), which found that long-term screen use, especially in young adults addicted to smartphones, results in significant eye and musculoskeletal stress [6]. After the guided exercise manipulation, all the domains experienced the severity of symptoms at mild levels (3.56 to 3.76). This level of reduction was significant according to the results of Wilcoxon signed-rank z values ranged between -9.302 and -9.368, with p-values of <0.001. In this current study, comparisons between the intervention and control groups were made, and noted that the intervention group had statistically significantly more reduction in symptoms (mean rank 66.21 vs. 48.79; p=0.004). This difference leads to a clear between-group difference that not only increases the internal validity of the results, but also indicates the effectiveness of guided eye exercise over simply the placebo or time effects.

Blinking was one of the most widely used exercises in 21.1% of participants, as a strategy to restore tear-film homeostasis due to the altered blinking frequency when interacting with screens. Hirzle et al. (2022) demonstrated that people tend to blink 60 to 70 percent less frequently when using digital devices, triggering ocular surface de-wetting and dryness [16]. Structured, organized blinking has also proven to have a positive effect on tear stabilization and an improvement and reduction of symptoms of dry eye through controlled trials, including more emphasis on a complete blink. The results of this study align with controlled dry eye trials by Kim et al. (2020), examining that participants who undergo blinking exercise experienced a decline in the number of symptoms associated with dryness; i.e., increased tear-film longevity [17]. Moreover, a recent TFOS Lifestyle Report and its recommendations lend additional value to the inclusion of the blinking exercises as the central part of the DES interventions, lending additional insight into the reasoning behind the therapeutic value of the study findings.

Accommodative fatigue is a hallmark of prolonged near-vision work. It was addressed by focus-shifting exercises, which were done by 20 20 20, used by 17.5% of participants. In this rule, the user looks at an object 20 feet distant for 20 seconds, every 20 minutes. Rosenfield et al. (2023) used a comprehensive program that incorporates the 20 20 20 rule among other elements, which has been demonstrated to lower visual strain to a great extent [18]. These findings are consistent with the outcomes of our program, whereby incorporation of 20 20 20 breaks into a wider exercise regimen has been found to reduce blurry vision and general fatigue. This effect indicates enhanced relaxation of the ciliary muscles and accommodative reset that is important in decreasing near-work symptoms.

Blurred vision was also enhanced through focus-shifting exercises and pencil push-ups (14.9 percent and 10.5 percent, respectively). These procedures focus on the active participation of accommodation and convergence systems. Though they are frequently employed in vision therapy to treat convergence insufficiency, they seem to have a wider application to treat visual fatigue. Pencil push-ups could be used to retrain the lens-displacement reflex and the coordination of vergence, thus enhancing far-to-near visual transfers and lessening blurred vision. Eye rolls (14.0%), palming (12.3%), and diagonal eye movement (9.6%) were more probable causes of neuromuscular relaxation. These methods correlate with parasympathetic stimulation that lowers stress, tension, and headache. Eye roll exercises that involve slow, purposeful movement of the eyes along different axes activate extraocular muscles and may reduce stiffness that can cause cervical pain. Palming, a method of closing eyes and firm pressure exerted by cupping of hands, creates ocular and mental relaxation.

Behavioral intervention efficacy is built on compliance. Among the participants in the study, 20.2% of the participants stated that they followed the recommended routine perfectly, and 71.9% engaged regularly. Such a compliance rate is due to easy and short exercises that occupy a few seconds and could be readily used as breaks in the course of digital use. The finding is consistent with the Brieflands et al. (2023) findings of behavioral psychology that low-effort and routine-integrated work are essential to long-term user compliance [19]. The perceived benefits were reflected as high reported satisfaction (59.6% moderate improvement, 14.0% significant improvement), and the qualitative feedback of over 92% of the participants is further evidence of positive reinforcement of the perceived benefits, translating into the further entrenching of habits.

The study supports and expands the current studies on the non-pharmacological interventions of DES. Specifically, a study by Hirzle and colleagues (2022) reported statistically significant symptom improvement due to multifaceted eyework programs in virtual reality users, which is analogous to decreased symptoms in the real world. The study by Kim et al. (2020) indicates the efficacy of blink exercise in dry eye disease and shows the patterns of improved symptoms. Also, the blinking and break reminder interventions have demonstrated a considerable decrease in tear-film characteristics and symptoms that align with the results and the overall tendency that user behavioral guidance by means of reminders leads to better clinical outcomes. Although Rosenfield et al. (2023) cast doubt on the independent success of the 20 20 20 rules, the study combined procedure allows assuming that the combination of it with muscle-flexibility training, break tactics, and eye movement activities has a positive impact even on controversial aspects [20]. Moreover, the evidence-based TFOS lifestyle reports support vision restorative breaks, blink strategies, and the role in preserving the integrity of the ocular surface and avoiding fatigue [20].

Although this study shows a high level of evidence that guided eye exercise can significantly reduce digital eye strain but it has several limitations. First, it depended on a self-reported symptom score that can be subjective and biased. Clinical accuracy was restricted as objective measures such as blink rate, TBUT, or accommodative response were not included. Secondly, short-term effects were measured only, and there was no follow-up to see whether the significant effects were maintained. The smartphones were used mostly by participants, which can be a limitation to the applicability of findings to those who used laptops or desktops.

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The intervention also involved several exercises, but did not assess the effects of each exercise separately, and it is not evident which exercises are more effective. Finally, the research did not choose random groups, weakening causal inferences.
Research in the future needs to rely on objective clinical instruments and symptom surveys to verify outcomes. Researchers should also find out the effectiveness of guided eye exercises over a long period and make regular follow-ups [21]. It would be useful to conduct the exercises individually and find out which of them is more effective. To enhance accessibility and compliance, it may be useful to add digital solutions that enable sending reminders through apps. In addition, specific interventions are to be tailored toward those high-risk groups, like office workers or students, following their screen usage patterns [22]. The reliability and relevance of findings would also be increased with randomized controlled trials.
The study shows that a guided program to exercise the eye is a feasible, locally available approach to managing DES. These interventions could be proposed by the ocular health professionals as a primary intervention, and they should be simple and versatile. The list of simple exercises include blinking, focus shift, rest breaks within minutes and stretching of eyes do not need much time or resources and can be taught by eye care clinicians to the patients [23]. Guided breaks can be built into work process (e.g. software reminder every 20 minutes) in the corporate or educational environments to facilitate eye comfort, productivity, and visual well-being.
Considering the proposed use of the DES among young, highly digitally exposed individuals, the increasing popularity of DES leads to the need to develop interventions with low cost and scalability. Guided workouts can be published through campaigns in the direction of health in society, wellness programs in schools, and online wellness platforms. These solutions are also equity-friendly since they do not need any specific equipment, especially in low-resource settings.

CONCLUSION

Based on the results of this study, guided eye exercises were found to be highly effective in reducing digital eye strain and related symptoms such as eye fatigue, dry eyes, blurred vision, headaches, and neck pain among young adults. Statistically significant improvements were observed post-intervention, particularly among participants who practiced the exercises consistently. High levels of adherence and positive participant feedback further support the practicality and perceived effectiveness of the intervention. These findings suggest that guided eye exercises are a simple, low-cost, and beneficial approach to managing digital eye strain in screen-exposed populations.

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