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Evaluating the Strength of Evidence on the Effectiveness of Accommodative Support Lens on Computer Vision Syndrome

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Abstract
Computer vision syndrome is a disease that has emerged with the advent of the computer and digital age. It is most associated with long-hour users of digital screen devices. Its symptoms are ocular and extraocular and may include blur or double vision, and other visual discomforts such as redness, irritation, dry eye, watery eye, headache, neck and shoulder pains, back aches and tendonitis. Several studies have reported a prevalence rate of between 10-90%. Depending on a number of factors, different treatment approaches have been adopted by physicians for primary and secondary care. These approaches include optimization of ergonomics, progressive addition of lenses, use of nutritional supplements, and artificial tears. The validity of the efficacy of these approaches has continued to generate debates among public health stakeholders due to limited evidence. This article discusses the strength of evidence of the use of accommodative support lenses in alleviating the symptoms of computer vision syndrome, with a special focus on the work of Seguí-Crespo et al., 2022.

Keywords: Computer Vision Syndrome, Accommodative Lenses, Occular, Extraoccular, Digital Screen, Ergonomics

1. Introduction

1.1 Computer vision syndrome

Computer vision syndrome (CVS) defines a set of eye and vision-related symptoms found in ardent users of computer screens and other digital video display terminals (Singh *et al.*, 2022). Symptoms of CVS are associated with either ocular surface resulting from dryness, burning, tearing, irritation, or with ocular interior aberrations from refractive errors, and accommodative or binocular vision errors (Seguí-Crespo *et al.*, 2022). Common symptoms of CVS include blurred vision, double vision, visual discomfort, dry eye disease (DED), redness, irritation, and watery eye. Extraocular symptoms of CVS include headaches, neck and shoulder pains, back aches, and thumb or wrist tendonitis (Alamri *et al.*, 2022). About 40% and 80% of CVS prevalence have been reported in adults and teenagers, respectively. Studies have indicated population prevalence ranging from 10% to 90% in different communities (Iqbal *et al.*, 2021).

The majority of the symptoms of CVS are temporary, recurrent, prone to progression, and may not resolve at the close of working hours (Singh *et al.,* 2022). The biological mechanisms of some of these symptoms are not well defined, and may also be dependent on other factors like ergonomic designs of the workstations. Some CVS symptoms are worsened by age and length of use of the device. Early studies indicate risk factors for CVS as the duration of computer device use (over 2 hours per day), glare and reflections on the device screen from surrounding lighting, humidity lower than 40%, and poor ergonomics (Singh *et al.,* 2022). The multifactorial nature of CVS symptoms makes studies in the field prone to 'effect modification' or 'interaction' bias, which has to be considered and attenuated in study designs (LaMorte and Sullivan, 2016). Many researchers have postulated that the blue light (short-wavelength visible light) from the computer screen causes CVS eye strain and may worsen accommodation. This has however remained contentious due to the lack of supporting evidence, the absence of convincing biological mechanisms, and the low level of emission of blue light in modern digital screens (Singh *et al.,* 2021).

1.2 Approaches to CVS Diagnosis and Treatment

In primary vision care, a range of symptom-targeted case-definition questions are used to diagnose CVS in patients who use computers regularly. The questions also determine the frequency and intensity of symptoms. Laboratory confirmatory tests may be required for confirmation of some ocular abnormalities. The CVS diagnostic questionnaires have been used by many researchers across the world to clinically identify CVS (Singh *et al.,* 2022). The questionnaire was standardized and validated as CVS-Q© by Segui *et al.* (2015). Clinical management of CVS incorporates several treatment approaches ranging from ergonomics optimization; applying the 20-20-20 rule (viewing an object 20 feet away for 20 seconds every 20 minutes) (Coles-Brennan *et al.,* 2019); progressive addition of spectacle lenses (Kee *et al.,* 2018) and blue light blocking spectacle lenses (Lin *et al.,* 2017); use of oral antioxidant and nutritional supplements like oral omega-3 fatty acid supplements and bilberry extracts (Bhargava *et al.,* 2013, 2016; Ozawa *et al.,* 2015); use of artificial tears (Blehm *et al.,* 2005); and traditional medicines such as *Triphala arka* (a polyherbal ayurvedic medicine) and *Saptamrita lauha* (a compound herbomineral ayurvedic formulation) (Gangamma *et al.,* 2010). Some of these treatment approaches are advertised directly to patients despite limited evidence of their efficacy. For instance, progressive addition of lenses is promoted for reduced CVS symptoms in pre-presbyopic adults (Kee *et al.,* 2018), and in non-presbyopes (Koh *et al.,* 2020); blue light-blocking spectacle lenses are promoted to lessen symptoms of eye strain from digital-screens (Essilor, 2022 and Zeiss, 2021, as cited in Singh *et al.,* 2022); oral omega-3 fatty acids nutritional supplement is believed to lessen dry eye symptoms (Bhargava *et al.,* 2013, 2016); and artificial tears are promoted as lubricants for the ocular surface to lessen CVS symptoms (Blehm *et al.,* 2005; Coles-Brennan *et al.,* 2019).

Contemporary preventive lifestyle for CVS accommodative problem recommends the use of newer designs of spectacle lenses with progressive-power options for pre-presbyopic individuals (Segui-Crespo *et al.,* 2022). Such spectacle designs are equipped with 'accommodative support' (AS) to reduce accommodative demands during extended use of digital screens (Wahlberg *et al.,* 2010). Despite the perceived benefits, there has been no definite consensus on the efficacy of low-plus lenses on CVS due to a lack of reliable, valid, and conclusive data from randomized controlled trials (RCTs) (Brautaset *et al.,* 2008; Wahlberg *et al.,* 2010; Yammouni and Evans, 2020). Another limitation in previous studies was the study duration which was considered short to expose the longer-term effect of accommodative spectacles. It is against these considerations that a more recent epidemiological study by Segui-Crespo *et al.* (2022) to determine if accommodative support lenses improve CVS symptoms, is being discussed for public health relevance.

2. Discussion

2.1 Strength of Evidence on Accommodative Support Lenses

The prospective double-masked randomized controlled trial by Segui-Crespo *et al.* (2022) explored the effect of accommodative support lenses on CVS symptoms, its perceived benefit from the binocular vision and accommodative functions, and the consequence on binocular and accommodative functions if used for 6 months. The study which was based on CVS-Q© score indicated that accommodative support lenses did not produce significant CVS symptom improvement in pre-presbyopic adults. It also indicated that there was 'no adverse effect

on optometric function (including accommodation)' associated with wearing accommodative support lenses. While these outcome interpretations may be of reasonable relevance in contemporary public health, it is important to critically evaluate the study for epidemiological weakness or limitations for planning public health intervention or improving future studies.

The risk factors for CVS are multifactorial and may range from individual demography and genetic makeup to environmental factors (humidity) and workstation ergonomics. As a result, non-RCTs and RCTs studies face bias from participant selection (random), data collection and confounding, which contribute to weakness and limitation of study evidence, and downgrade its reliability and validity, as well as limit outcome interpretations and applicability (Matsui and Keet, 2017; Pinchbeck and Archer, 2020). For instance, the effect of confounding such as low-level uncorrected astigmatism (0.50–1.00 DC), and other underlying vergence problem may be implicated in CVS accommodative symptoms and may invalidate an otherwise good study (Seguí-Crespo *et al.,* 2022).

The study under examination was appropriately conceptualized to understudy the long-term advantage of the use of accommodative support (AS) lenses over single vision (SV) lenses in improving CVS symptoms adduced to accommodative demands using CVS-Q©. The research questions were appropriately based on hypotheses and scope of study to adequately address the aim. All participants attained a minimum CVS-Q© score of 6 to confirm CVS at baseline before being randomized in double-masked randomization. Perhaps a higher score of about 12 (closer to the mode of the selected participants) could have been more definitive of a more homogenous population for participant selection. The major weakness in the focus of the study arises from the fact that the definition of CVS and its symptoms as provided in CVS-Q© is multifactorial and may not be reduced by fixing accommodative problems alone. In my view, this was also not adequately addressed in the design and methodology.

The double-blind RCT was adequate to eliminate selection bias after screening selection, however, the inclusion and exclusion criteria were limited in scope. The criteria did not provide for variability in ergonomics, environment humidity and air-pollutant, duration of screen use, user workload and associated psychosocial stress, use of a nutritional supplement, level of physical activity, as well as the socioeconomic status of participants. The study did not indicate whether the presence of other non-CVS health conditions, which could have affected extraocular symptoms (neck, shoulder, and headaches) and baseline health status, were included in the exclusion criteria. Hereditary disposition (astigmatism), age, and gender are risk factors for CVS and accommodative loss (Dirani *et al.,* 2008; Lockhart and Shi, 2010; Sun *et al.,* 1988), and could be sources of confounding. Some studies have shown that accommodative problems become more apparent from above age 30yrs (Sun *et al.,* 1988), but this study recruited participants of age 18-40yrs. These confounding factors were not adequately eliminated.

The study design of double-blind RCT attempted to eliminate selection bias significantly (Matsui and Keet, 2017; Pinchbeck and Archer, 2020). Primary selection bias may still have been carried over from the screening or pre-randomization stage. Such bias may affect mean age, workload, and ergonomics. The attrition rate was low (2.2%), and hence the study did not suffer from attrition bias. In addition to the biases discussed above, self-reporting questionnaires such as CVS-Q© are very subjective and often prone to 'recall bias'. Follow-up studies of this nature where participants were followed up monthly for reminders, and then assessed on the 3rd and 6th month, are also prone to 'differential assessment bias' as the study progress, and/or 'exposure suspicion bias' where there is suspected outcome development by the data collector or the participant. The laboratory confirmatory test at baseline, 3rd, and 6th months may have minimized some of the self-reporting 'information bias'.

The confirmatory data collected were typical for accommodative vision. The analysis of results was adequately performed by comparing AS (treatment group) and SV (control group) using Microsoft Excel (version 2102) and IBM SPSS (version 26) tool. The preference for the AS spectacles by the control group at the end of the study may be an indication of the improvement of CVS by AS lenses. However, it was not adequately studied since it was unmasked and subject to 'reporting bias'.

The authors' conclusion that the AS did not confer any advantage on resolving CVS was appropriate and based on the fact that there was no improvement in CSV-Q© score over 3 to 6 months. The study also found no strong

optometric correlation between the use of accommodative lenses and improved CVS (Segui-Crespo *et al.*, 2022, pg. 92).

2.2 The Implication of the Strength of Evidence

According to the hierarchy of evidence, evidence from the RCT study is rated Level 2, and is more reliable and generalizable than Level 3 and beyond (Krueger, 2022). The double-masked RCT study by Segui-Crespo *et al.* (2022) falls into this category and was appropriate although it contains certain weaknesses from the biases discussed above, which may have downgraded its reliability and validity for public health applications.

As earlier discussed, the study did not show adequate provision for the elimination of information bias and confounding from other risk factors of CVS. It also did not attempt to explain limitations due to 'effect modification' or 'interaction' from differences in the socioeconomic status of the participants, and other CVS multifactorial variables like humidity, air-irritants, ergonomics, heredity, nutritional supplements, gender, age, and workload, on participants' accommodative response and CVS-Q©. Statistical interactions due to interloping third variable(s) were not adequately discussed (LaMorte and Sullivan, 2016). The existence of these biases from uncontrolled confounding factors provides a basis to question the reliability and internal/external validity of the study. The statistical power for sample size determination was not stated. The sample size appears small hence the study may not be reliable and internally valid.

There will be bias in the estimate or interpretation of outcome variables when confounders are not statistically adjusted for or explained to establish perspectives to the limitation of the study (LaMorte and Sullivan, 2016). This may create divergence among study populations or groups when no real divergence exists, or/and a report of an association when there is truly none. Confounding can also result in under or over-estimation of study outcomes (Public Health Action Support Team, PHAST, 2022). Finally, the study was sponsored by the industry and therefore prone to bias from conflict of interest.

3. Conclusion

Computer vision syndrome is a growing occupational health risk among computer users. Accommodative vision problem is one of the symptoms of CVS. Many researchers have theorized that accommodative problems in CVS could be ameliorated with the use of accommodative support lenses. Earlier studies to investigate the correlation between accommodative support lenses and attenuation of CVS symptoms showed several limitations including a lack of randomized controlled trials and short study duration. The study by Segui-Crespo *et al.* (2022) aimed to investigate the correlation between improved CVS symptoms and the use of accommodative support lenses in a double-masked randomized controlled trial, over a longer period of six months. The study aim, research questions, hypotheses, and design seemed appropriate. The methodology shows loopholes and susceptibility to biases. The sample size statistical power was not stated, and the sample size was small compared to similar CVS studies by Iqbal *et al.* (2021). The conclusion that there was no strong correlation between wearing accommodative support lenses and improvement in CVS symptoms and no adverse effect on optometric function due to the use of accommodative support lenses seemed appropriate. The biases of note in the study include systemic biases such as information bias and confounding bias. These biases suggest that the study may not be reliable and valid, limiting its public health application. Subsequent studies in the field should consider higher sample size and statistical power and attenuation of confounding factors of astigmatism, environment, ergonomics, and workload, amongst others. Despite the foregoing, the no-benefit conclusion of the study will assist public health officials to make more appropriate decisions on CVS interventions and future studies. This will help in the efficient deployment of resources.

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Conflict of Interest

There is no conflict of interest. The author has no specific financial or material interest in developing the manuscript other than to contribute to scientific knowledge on CVS. There was no specific funding from any funder.

Ethical Approval and Consent

The article does not include any primary data from enrolled participants. It does not contain any collection or report of primary biological data or any participants' identifying information. Hence no ethical approval of study was necessary.

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Author Contribution

HOE conceptualized, conduct literature review, and developed the manuscript.

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