Ophthalmol Ther (2023) 12:2813–2816
https://doi.org/10.1007/s40123-023-00759-0

LETTER

Letter to the Editor Regarding "Blue Light Exposure: Ocular Hazards and Prevention—A Narrative Review"

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Received: March 19, 2023 / Accepted: June 15, 2023 / Published online: July 10, 2023

Keywords: Light emitting diodes, LEDs; Computer vision syndrome, CVS; Multifocal electroretinogram, mfERG; Screen-induced foveal dysfunction; Retinal phototoxicity; Reactive oxygen species, ROS; Smartphone

Dear Editor,

We have read with great interest the review article by Cougnard-Gregoire et al. [1] entitled "Blue light exposure: ocular hazards and prevention—a narrative review." We congratulate Cougnard-Gregoire et al. for their recent publication yet partially disagree with their outcomes and conclusions. Light-emitting diodes (LEDs) emit rich blue light and are used in the manufacturing of several types of screens such as smartphones, tablets, laptops, desktop computers and televisions. However, we have one major concern regarding their narrative review as we are surprised that the authors did not notice our recently published articles and the clinical trials presented by Iqbal et al. [2–4] during their search of the literature.

Our major concern relates to their final conclusion about LEDs in digital screens: "Currently, there is no evidence that LEDs in normal use at domestic intensity levels or in screen devices are retinotoxic to the human eye." We disagree with their conclusion as we have already proved the existence of screen-induced foveal dysfunction affecting macular integrity in three published clinical trials [2–4]. To our knowledge, we are the first scientific team to document the multifocal electroretinogram (mfERG) changes representing a reduction in foveal function with corresponding associated reduction in the visual performance in medical students suffering from computer vision syndrome (CVS) due to prolonged screen-hours and excessive exposure to several types of blue light-emitting electronic devices, mainly smartphones, pads/tablets, laptops and desktop computers [2–4]. Most of these students were involved in the mandated computer system use program in their colleges.

This comment refers to the article available online at https://doi.org/10.1007/s40123-023-00675-3.

An author's reply to this comment is available online at https://doi.org/10.1007/s40123-023-00760-7.

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We used the mfERG according to the mfERG standard protocol of the International Society for Clinical Electrophysiology of Vision (ISCEV) to document the first foveal peak and amplitude density (P1 AD) in the mfERG rings and quadrants in both controls and CVS cases. Our studies [2–4] included two groups: the control groups, which included participants with no-CVS (controls/normal subjects) with average total daily screen-hours < 3 h, and the CVS groups, which included participants with documented CVS diagnosis based on Iqbal's four major criteria for accurate CVS diagnosis [5] and average total daily screen-hours > 5 h. Our recorded mfERG findings in the control groups revealed preserved foveal peaks while the mfERG rings and quadrants were within normal ranges. Contrarily, the CVS groups revealed statistically significant reductions in P1 AD in most mfERG rings and quadrants with reduced foveal responses. Moreover, the CVS groups exhibited statistically significant reductions in both uncorrected and corrected distance visual acuities (UDVA and CDVA, respectively) compared to the control groups. Our documented reduced foveal responses with mfERG changes and associated corresponding reduced visual performances were named 'screen-induced foveal dysfunction.'

Moreover, we analyzed the outcomes of screen-time reduction on the foveal responses associated with CVS by recording UDVA and CDVA together with the first and second (repeat) mfERG examinations in control versus CVS groups before and 4 weeks after reduction of total daily screen-hours to ≤ 1 screen hour daily [4]. We documented remarkable significant improvements in foveal responses in CVS cases 4 weeks following strict screen-time reduction to ≤ 1 screen-hour daily. The strict screen-time reduction was based on Iqbal's instructions to guard against CVS as described in our Methods section [4]. In addition, we recorded a positive correlation between the differences in the daily screen-hours reduction and mfERG rings and quadrants P1 AD [4, 6]. Therefore, the fewer the daily screen-hours with less exposure to screens, the greater the improvements in foveal responses are.

Based on our studies, we believe that the documented screen-induced foveal dysfunction in our clinical trials [2–4] is a potential type of retinal phototoxicity associated with excessive exposure to electronic devices and LEDs encountered in screens, mainly smartphones, pads/tablets and laptops. We have already shown that this type of potential associated retinal phototoxicity has a temporary adverse effect on foveal function and macular integrity, which can be reversed by restriction of screen time. Therefore, we recommended that higher educational authorities should re-plan the mandated computer system use program and consider other alternatives [4].

We believe that screen-induced foveal dysfunction is a reversible retinal phototoxicity phenomenon in the short term that adversely affects visual performance; however, we do not know the long-term adverse effects that could lead to potential permanent retinal damage. Furthermore, we also acknowledge that we have no obvious explanation for the pathophysiological mechanisms underlying our outcomes; they might be related to macular cone/bipolar cell dysfunction because of cone adaptation due to exposure to high levels of blue light emitted from screens. Therefore, CVS patients usually suffer from screen-induced foveal dysfunction with blurred vision and see unclear objects post-screen use with reduction in visual performance.

Several explanations for the potential underlying mechanisms of action of blue light-enriched LEDs in inducing retinal damage have been postulated, such as increased production of reactive oxygen species (ROS) with oxidative stress and cell death as described by Abdhou et al. [7]. In their review study, Touitou and Point [8] addressed the potential health and ocular sequelae of LEDs with their underlying mechanism of action. They concluded that LEDs are potentially harmful to human eyes and sleep patterns with potential retinal phototoxicity and biological clock disturbances. In an interesting experiment, Moon et al. [9] showed that 48-h exposure of the retinal cells to a 449-nm low-intensity blue light, like that emitted from electronic devices, resulted in three times increased production of ROS compared with dark-incubated controls. They

concluded that low-intensity blue light like that emitted from screens enhances ROS production with subsequent retinal cell damage.

We are grateful to the Editorial Board of Ophthalmology and Therapy for publishing such remarkable studies and congratulate Cougnard-Gregoire et al. [1] for their recent publication.

ACKNOWLEDGEMENTS

Funding. No funding or sponsorship was received for this study or publication of this article.

Authorship. The named authors meet the International Committee of Medical Journal Editors (ICMJE) criteria for authorship for this article, take responsibility for the integrity of the work as a whole, and have given their approval for this version to be published.

Author Contributions. Concept and design (Mohammed Iqbal, Ahmed Elmassry, Omar Said), formal analysis and investigation (Mohammed Iqbal, Ahmed Elmassry, Omar Said), drafting the manuscript (Mohammed Iqbal, Ahmed Elmassry, Omar Said), review and approval of the final version (Mohammed Iqbal, Ahmed Elmassry, Omar Said).

Disclosures. The authors of this letter (Mohammed Iqbal, Ahmed Elmassry, Omar Said) have no personal, financial, commercial or academic conflicts of interest to declare.

Compliance with Ethics Guidelines. This article is based on previously conducted studies and does not contain any new studies with human participants or animals performed by any of the authors.

Data Availability. Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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