

# **EDITORIAL**

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# Seeing beyond reality: considering the impact of mainstream virtual reality adoption on ocular health and the evolving role of ophthalmologists

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*Eye* (2024) 38:1401–1402; https://doi.org/10.1038/s41433-023-02892-3

The unveiling of Apple's VisionPro headset on June 5, 2023 signifies a crucial transition in the realm of consumer-oriented Mixed Reality (MR) experiences. Current Virtual Reality (VR) devices are primarily tailored for single-focus time boxed experiences, predominantly in gaming. In contrast, the introduction of Apple's VisionPro and Meta's Quest 3 has showcased the vision to seamlessly incorporate Augmented Reality (AR)/VR experiences into the daily routines of the general populace. These devices have been engineered to accommodate a diverse array of activities including work, fitness, education, and leisure. Furthermore, their incorporation of a pass-through video feed of the user's environment drastically reduces the need for removal in comparison to conventional VR devices. As the adoption of these devices grows, it is essential to consider their implications for ocular health.

# A WEALTH OF OPPORTUNITY

Virtual Reality (VR) devices, with their array of sensors and highdefinition displays, have significant promise in the field of ophthalmology. To date, VR has significantly contributed to three key domains: therapeutics, diagnostics, and surgical aids.

One of the foremost applications of VR in ophthalmology is in therapeutics. Spatial computing capabilities allow for the creation of immersive environments tailored for vision training, assisting individuals with visual impairments in refining their visual acuity, depth perception, and hand-eye coordination. For example, VR tools can be instrumental in preventing and managing myopia by effectively mimicking outdoor environments while controlling light intensity and spectral composition [1]. By combining eyetracking and foveated rendering, VR displays can effectively simulate the paracentral defocus state and manage ocular axis lengthening. A study examined the combination of low-dose atropine with VR-supported binocular vision function balance training in treating 136 patients with juvenile myopia [2]. Compared to standalone low-dose atropine treatment, those who received the combined therapy exhibited significantly improved unaided vision and larger pupil diameters. The study also reported a significant decrease in dioptre correction following the intervention, with no change in adverse reactions. Another study investigated the impact of autostereoscopic 3D visual training on the accommodative functions of individuals with myopia [3]. Here, 46 participants watched a video depicting a moving target alternating between a point 50 cm in front of the screen and a point 500 cm behind it, with pauses at both ends. The results indicated a reduction in accommodative lag and an enhancement in accommodative facility post-training. Furthermore, analogous research has been carried out on the use of VR in treating other ocular conditions like amblyopia [4–7]. Taken together, VR devices exhibit strong promise as a treatment modality.

Additionally, with MR becoming more commonplace, MRcapable devices can be used regularly outside the clinical setting allowing for at-home diagnosis and monitoring of ophthalmologic conditions. Capitalizing on the capabilities of spatial computing can allow individuals to proactively manage their eye health, identify initial indicators of vision-related disorders, and consult healthcare professionals as needed. For instance, recent studies have reported the possibility of monitoring glaucoma and tracking visual field loss over time via virtual visual field testing at home [8]. Notably, all 20 participants found the VR-based visual field testing easy to use, with most favouring this method over the standard of care Humphrey Field Analyzer used in clinical settings. Preliminary studies also indicate that virtual visual field testing is comparable in performance to the conventional Humphrey visual field testing, widely recognized as the gold standard [9, 10]. These encouraging findings highlight the significant potential of VR technologies in facilitating homebased eye diagnostics.

In addition to the impact on patients, spatial computing can offer considerable benefits for surgical applications and training. VR simulators, such as Eyesi (VRmagic, Mannheim, Germany) and MicroVisTouch (ImmersiveTouch, Chicago, Illinois), have already become routine training tools for microsurgical techniques employed in numerous ophthalmology education programs [11–13]. By providing aspiring ophthalmologists with the opportunity to rehearse complex procedures in lifelike virtual environments, students can acquire practical skills in a safe and controlled setting.

# A CALL FOR CAUTION

Given Apple's and Meta's extensive reach into the lives of so many, and the unstudied impact of long-term MR usage, it is imperative that the ophthalmology community provides the necessary guidance and research to confirm that this technological shift does not compromise public health. Critically, we must emphasize daily-usage guidelines.

It is crucial to understand that extended periods in virtual reality environments can have negative effects on eye health. Prolonged exposure to artificial light, particularly blue light emitted by VR headsets and displays, has been linked to a range of eye conditions, including digital eye strain, dry eye syndrome, and fatigue [14–16]. Studies also suggest that excessive blue light exposure can interfere with circadian rhythms, causing sleep disturbances and possibly increasing the risk of eye diseases such

Received: 6 November 2023 Revised: 18 November 2023 Accepted: 4 December 2023 Published online: 14 December 2023

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as age-related macular degeneration [17–20]. Many VR devices feature low resolution and limited visual fields, which could ironically hasten the onset of myopia and other accommodative and vergence issues [1]. These effects may be intensified by extended use, as users, captivated by immersive experiences, might neglect to blink as frequently as necessary. There are also several broader healthcare concerns of screentime on youth populations — such as the positive correlation between screentime and the risk of ADHD, which could be applicable to VR screentime as well [21–23].

Increased research that considers the changing user dynamics of AR/VR devices and cogent public health communication are essential to safeguard the health of users as these devices become increasingly integrated into daily life.

# CONCLUSION

Ophthalmologists play a vital role in understanding and addressing the ocular health consequences of extended virtual reality experiences. It is incumbent upon us to conduct further research to better comprehend the long-term effects of VR usage and to develop evidence-based guidelines for safe and responsible integration with clinical care.

Furthermore, collaborations between ophthalmologists and VR developers can facilitate the creation of ocular-friendly VR experiences. This could involve optimizing display technologies to reduce blue light emissions and developing eye-tracking capabilities to ensure accurate and natural eye movements within the virtual environment. Such collaborations can enable the integration of ophthalmic expertise in the design and development of VR experiences, promoting ocular health while maintaining its immersive nature.

In conclusion, the increasing prevalence of MR experiences necessitates a comprehensive understanding of their impact on ocular health. By acknowledging both the positive and adverse effects, ophthalmologists can guide patients, developers, and policymakers toward safe and responsible MR/VR usage. Through continuous research, education, and collaboration, we can harness the transformative power of spatial computing while safeguarding the precious gift of sight.

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# ACKNOWLEDGEMENTS

We are thankful to our colleagues at the Baylor College of Medicine, Texas Children's Hospital, the Jan and Dan Duncan Neurological Research Institute, and the Alkek Eye Center who provided expertise that greatly assisted this research.

# AUTHOR CONTRIBUTIONS

VSJ and BJF collaborated closely on conceptualizing and framing the scientific comment. VSJ provided insights and perspectives and analyzed relevant literature. BJF played a substantial role in guiding the overall direction of the comment, offering expertise in the field, and overseeing the writing process. Both authors actively participated in drafting and revising the manuscript.

# FUNDING

VSJ is supported by the Gulf Coast Consortia and the National Library of Medicine Training Program in Biomedical Informatics and Data Science [T15 LM0070943]. BJF is supported by NIH grants [EY025601, EY033458, EY032596].

#### **COMPETING INTERESTS**

The authors declare no competing interests.