

The Impact of Virtual Reality on ocular functions

The background is split into two main sections. The left section is dark grey with several 3D cubes of varying sizes and orientations, some appearing to float or fall. The right section is a lighter blue-grey gradient, featuring a complex network of white dots connected by thin white lines, resembling a molecular or data network. There are also several white circles of different sizes and one solid purple circle on the right side.

Does the use of visors worsen
ocular conditions?

Why the concern?



Virtual Reality is a relatively new technology



VR use is rapidly increasing in popularity



Virtual Reality is now used for gaming purposes



VR visors are becoming more and more affordable

Cybersickness

Motion Sickness caused by VR use

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graph TD; A[Motion Sickness caused by VR use] --> B[Due to the delay between the head movement and the same movement reciprocated in the virtual environment]; B --> C[Newer and better visors are reducing Cybersickness effects];
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Due to the delay between the head movement and the same movement reciprocated in the virtual environment

Newer and better visors are reducing Cybersickness effects

Are there long-term issues?



Short-term issues like Cybersickness can be avoided with newer technologies



But does VR use impact vision or ocular functions like accommodation and vergence?

Waiting for answers



As the technology for commercial use is relatively new, it's hard to find longitudinal studies examining this



In the meantime, some researchers tried to pinpoint what could be the long-term effect by investigating other short-term ones

Three studies

After a brief research, some studies on the matter were selected

One for each year from 2019 to 2021 was chosen

Research was based on previous scientific claims of a presence or absence of effect on vision

Virtual reality games on accommodation and convergence (2019)

34 participants

6/6 vision with or without spectacles

Normal color vision

Good stereo acuity

Flexible accommodation

Low Phoria

Accommodative response and Phoria at distance and near were measured

Participants played a VR game for 30 minutes, then measurements were repeated

This lead in accommodation, paired with a lowered AC/A ratio, may cause visual discomfort

Researchers found a statistically significant difference in Accommodative Response, Horizontal Phoria and AC/A ratio

The effect of gaming on accommodative and vergence facilities after exposure to virtual reality head-mounted display (2020)

62 participants

18-30 years

Normal binocular vision

Common interpupillary distances

No spectacles and CLs users

Accommodation and vergence facilities were measured



Participants were randomly assigned to play a VR game or watch a movie on a normal 2D screen



Repeating measurements showed an increase in both groups, but statistically significantly higher in the VR one



The results may indicate a training effect on accommodation and vergence facilities

Effects of prolonged use of virtual reality smartphone-based head-mounted display on visual parameters: a randomized controlled trial (2021)

58 participants

20-39 years

20/20 vision

No ophtalmologic disorder

No history of ocular surgery

Refraction, accommodation,
ocular deviations,
convergence, stereopsis,
ocular dominance and
choroidal thickness were
measured



Participants were randomly
assigned to play a game on a
VR device or smartphone



A worsening of dry eye
symptoms and visual
discomfort was found with a
questionnaire



Repeating measurements
after 2 hours of gaming
showed a worsening in
stereopsis, accommodation,
convergence and ocular
deviations severity in VR
users

Conclusions

VR has an impact

Convergence and accommodation tend to worsen

Dry eye symptoms increase more than with smartphones and 2D screens

Cybersickness can be resolved in the future but is still an issue for now

Stronger visual issues worsen more than smaller ones

One study contradicted the other two, finding a positive training effect associated with VR use

However, longitudinal studies are needed to assess the actual impact of VR on long-time users.

Actual research has limitations (like an high dropout rate) which will hopefully be possible to avoid in future studies.

Bibliography

- Stephen Palmisano, Rebecca Mursic, Juno Kim, Vection and cybersickness generated by head-and-display motion in the Oculus Rift, *Displays*, Volume 46, 2017, Pages 1-8, ISSN 0141-9382, <https://doi.org/10.1016/j.displa.2016.11.001>.
 - Zulekha Mohamed Elias, Uma Mageswari Batumalai, Azam Nur Hazman Azmi, Virtual reality games on accommodation and convergence, *Applied Ergonomics*, Volume 81, 2019, 102879, ISSN 0003-6870, <https://doi.org/10.1016/j.apergo.2019.102879>
 - Munsamy AJ, Paruk H, Gopichunder B, Luggya A, Majola T, Khulu S. The effect of gaming on accommodative and vergence facilities after exposure to virtual reality head-mounted display. *J Optom.* 2020 Jul-Sep;13(3):163-170. doi: 10.1016/j.optom.2020.02.004. Epub 2020 Mar 28. PMID: 32234359; PMCID: PMC7301196.
 - Yoon, H.J., Moon, H.S., Sung, M.S. et al. Effects of prolonged use of virtual reality smartphone-based head-mounted display on visual parameters: a randomised controlled trial. *Sci Rep* 11, 15382 (2021). <https://doi.org/10.1038/s41598-021-94680-w>
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