Genetic differences may contribute to changes in astronauts' eyes

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Researchers have found that genetic variation may increase susceptibility of some astronauts to develop higher-than-normal carbon dioxide levels in the blood, which may contribute to eye abnormalities, including grooved bands on the retina in the eye and swelling of the optic nerve. The study is published in Physiological Reports.

Previous studies have shown that spaceflight can cause structural changes in the eye, including thickening of the tissues, nerve swelling and impaired vision. These changes are thought to be due to the shifting of fluids to the head that occurs with weightlessness. The slightly elevated carbon dioxide pressure in the air on the International Space Station is another possible cause for eye problems.

Because not all astronauts' eyes are affected, genetic differences may also play a role in vision impairment and structural abnormalities. A network called the "one-carbon pathway" allows enzymes to move carbon atoms around in the cells. Normal variances in the enzymes that act on the one-carbon pathway may make certain people more sensitive to changes in carbon dioxide levels and more likely to experience vision and physiological eye changes after long-term exposure to a weightless environment.

Researchers studied a group of male volunteers (average age: 35) who lay in a 6-degree head-downward tilted position that mimics fluid flow to the head during spaceflight. While in the tilted position, the men were exposed on different occasions to normal room air ("normal tilt") and air with increased carbon dioxide content ("CO2 tilt"). The research team also exposed the participants to room air while they sat upright ("control"). The researchers measured several physiological conditions and functions during each exposure, including:

- pressure of fluids in the eyes (intraocular pressure, or IOP);
- structural changes in the eyes;
- blood flow to the eyes;
- pressure around the brain (intracranial pressure); and
- heart rate.

The volunteers also took a vision test and completed a survey after each exposure, in which they reported if they experienced any symptoms associated with high carbon dioxide exposure, such as headache.

The participants' heart rate decreased, blood flow to the eye increased and intracranial pressure increased in both tilt sessions when compared with the control, but there was no significant difference between the normal tilt and CO2 tilt sessions. Both tilt conditions caused a small increase in IOP with pressure levels reaching the highest readings after carbon dioxide exposure. There were no significant differences in eye structure or changes in vision among the tilt tests or the control during the tests.

The research team identified the genetic variances in the one-carbon pathways through a blood test. They grouped the participants by the similarities in their genetic makeup, using previous research that had identified certain genes as "more likely" and "less likely" to be associated with ocular changes in astronauts. The group with genetics similar to the astronauts who developed eye changes had higher intracranial and intraocular pressure in the normal tilt, but not the CO2 tilt trials when compared to the less susceptible group.

"Grouping of subjects by genetic polymorphisms (variations) may provide promising insight into understanding the individual variability in many physiological outcomes that develop during spaceflight, including greater susceptibility to increased arterial [partial pressure of carbon dioxide] levels, potentially increasing the risk for symptoms related to CO2 exposure," the researchers wrote.

More information: Steven S. Laurie et al. Effects of short-term mild hypercapnia during head-down tilt on intracranial pressure and ocular structures in healthy human subjects, *Physiological Reports* (2017). DOI: 10.14814/phy2.13302

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