Potential Health Risks for FPV Drone Operators

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Abstract *FPV (first-person view) drones have quickly become essential assets in modern warfare, particularly due to their use in the ongoing Russia-Ukraine conflict. Their ability to deliver precise strikes and provide immediate situational awareness has significantly transformed battlefield dynamics. As the deployment of FPV drones continues to rise, it becomes imperative to address the potential health risks associated with prolonged and intense drone control. Issues such as visual strain, cognitive overload, and musculoskeletal problems pose particular challenges during extended operations. In response to the growing role of FPV drone technology in national defence strategies, this article seeks to bring to light the health risks faced by FPV drone operators. When considering the introduction of a potential FPV drone operator training program, it is important to not only establish the technical conditions but also implement preventive health measures to ensure the operational readiness and long-term well-being of the personnel.*

INTRODUCTION

FPV drones, initially developed for recreational and commercial use, have quickly evolved into powerful tools across various fields, including agriculture, search and rescue, surveillance, and more recently, military operations. Compared to UAVs (Unmanned Aerial Vehicles) commonly used so far, these drones differ in size and strikeability. Their versatility, cost-efficiency, and ability to provide real-time, immersive visual feedback have made them indispensable in high-stakes environments such as warfare, where precision and rapid decision-making are critical. The most dramatic example of their military application has emerged in the Russia-Ukraine conflict, where FPV drones have been used extensively for reconnaissance and tactical strikes. As shown in Figure 1, these drones are equipped with an advanced camera and video transmitter to enable the operator to see from the perspective of the drone via VR goggles. The rotors are controlled by the signal emitted by the operator's remote control and received by the remote-control receiver on the drone. This bidirectional low-latency communication

allows the operators to navigate complex terrains and engage targets with unprecedented accuracy, all while remaining far from the physical battlefield.

However, the rapid expansion of FPV drone usage raises important concerns regarding the long-term health impacts on operators, particularly in high-pressure

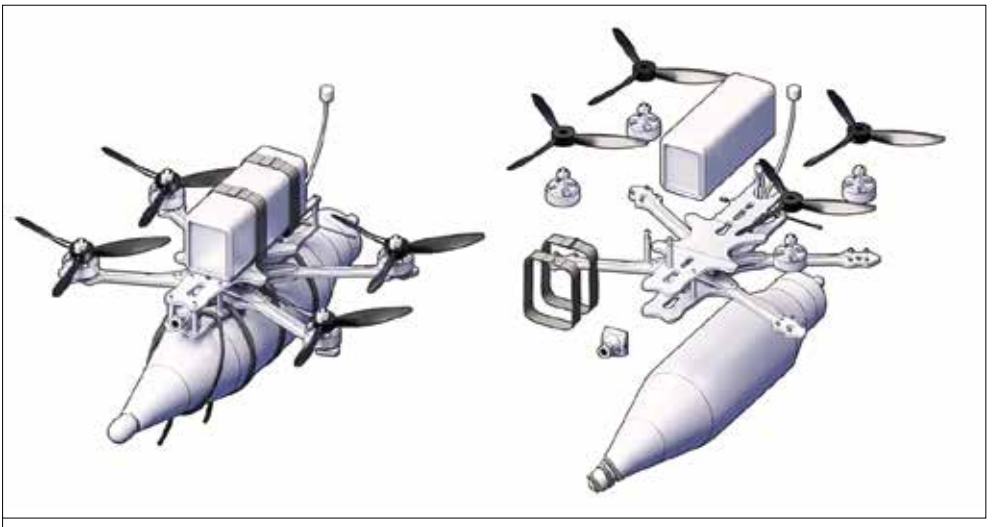

*Figure 1: FPV drone components (*https://www.ecssr.ae/en/research-products/reports/2/198140 *Downloaded: 21.10.2024.)*

*Figure 2: Drone pilot in operation with his squad (*https://www.atlanticcouncil.org/blogs/ukrainealert/fpv-drones-in-ukraine-are-changing-modern-warfare/ *Downloaded: 14.10.2024.)*

environments such as the military. Studies have shown that FPV drone operators are vulnerable to both physical and mental health risks, including visual strain, cognitive overload, and psychological distress. For example, research has identified a significant presence of mental health disorders, such as PTSD, among remotely piloted aircraft (RPA) operators, despite their physical distance from the battlefield. Furthermore, pilots have reported experiencing distress and trauma from viewing live combat through their drone cameras, leading to a need for better mental health support systems in both military and civilian contexts.

In addition to psychological risks, the physical demands of drone piloting, such as maintaining posture for extended periods and repetitive hand movements, pose significant ergonomic challenges. Studies have highlighted the importance of physical fitness in mitigating these risks, particularly in military settings where high performance is critical during prolonged missions.[1] As FPV drones continue to integrate into both military and civilian domains, understanding the full scope of these health risks is crucial for developing guidelines and preventive measures to protect operators from long-term harm. Consequently, this paper aims to explore the physical and mental health risks associated with FPV drone piloting, focusing on the unique demands posed by this emerging technology in modern warfare and beyond. These can help optimize the operator selection process, as the currently applied guidelines are typically based on the deployment of operational-level UAVs. The NATO STANAG 7192 AAMedP-1.25 can be taken as a reference for this process.[2] In contrast, FPV drones are used at the tactical level, therefore, other parameters may need to be considered.

PHYSICAL HEALTH ISSUES

Operating FPV drones, especially in demanding military environments, exposes operators to a variety of physical health risks due to the sustained focus, posture, and fine motor control required. The extended use of FPV goggles, along with intense hand-eye coordination tasks, puts a significant strain on multiple aspects of physical well-being.

Visual strain (Computer Vision Syndrome)

FPV drone pilots rely heavily on FPV goggles or screens, focusing intently on real-time video feeds for extended periods. This intense visual demand can result in digital eye strain, also known as Computer Vision Syndrome (CVS), which manifests as blurred vision, dry or irritated eyes, and head-

1 Galashevskyi, Hennadiy: *The importance of physical fitness of FPV drone operators in the process of performing combat tasks as intended*, 89.

2 Szabó, Sándor András, Hornyik, József: *UAV (pilóta nélküli légijárművek) műveletek repülőegészségügyi feltételrendszerének biztosítása,* 66.

aches. Studies suggest that prolonged exposure to digital screens can lead to exacerbated visual fatigue, especially in fast-moving tactical environments where constant refocusing is required. In military settings, pilots often work under challenging lighting conditions, such as low-light or high-glare environments, which further intensify these issues.[3]

Blue light exposure

FPV goggles and screens emit significant amounts of blue light, which has been linked to both short- and long-term eye problems. Short-term exposure contributes to eye fatigue and discomfort, while long-term exposure has been associated with an increased risk of macular degeneration and disrupted circadian rhythms. This disruption of sleep cycles is particularly concerning for military drone operators who are often required to conduct night missions, which can lead to fatigue and diminished alertness in subsequent operations.[4]

Neck and upper back pain

Wearing FPV goggles requires pilots to maintain a consistent posture, often with the head slightly forward, which can cause strain on the cervical spine and upper back muscles. Prolonged drone piloting sessions, particularly without proper posture or ergonomic support, are likely to result in chronic neck pain and tension. This static, hunched-over position is associated with musculoskeletal issues, such as "tech neck" and cervical muscle strain, which can impair a pilot's comfort and focus during missions.[5]

Repetitive strain injuries (RSIs)

The precise and repetitive movements required to control drones using joysticks or handheld controllers can lead to repetitive strain injuries (RSIs) in the hands, wrists, and fingers. Over time, this can develop into conditions like carpal tunnel syndrome, tendinitis, or trigger finger. In high-stakes military operations where precision and quick reflexes are essential, the cumulative strain on joints and muscles can lead to performance degradation and chronic pain.[6]

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3 Rosenfield, Mark: *Computer vision syndrome: a review of ocular causes and potential treatments.*

4 Ouyang, Xinli et al.: *Mechanisms of blue light-induced eye hazard and protective measures: a review.*

5 Galashevskyi, Hennadiy: *The importance of physical fitness of FPV drone operators in the process of performing combat tasks as intended,* 89.

6 Northey, G. W.: *The effects of stiffness and speed on upper limb electromyography during joystick use*, 4-8.

Hand and thumb strain ("Gamer's Thumb")

FPV drone controllers often rely heavily on thumb movements to operate joysticks or control switches. This repetitive thumb motion can lead to a condition known as de Quervain's tenosynovitis, or "Gamer's Thumb", where the tendons in the thumb become inflamed due to overuse. In military contexts, where swift and precise control is crucial, the risk of hand and thumb injuries is heightened, which can limit a pilot's ability to maintain prolonged control or react quickly in critical situations.

Lower back pain and posture-related issues

Pilots operating FPV drones from seated positions for extended periods can develop poor posture, leading to lower back pain and stiffness. Inadequate seating, lack of lumbar support, and static postures can contribute to musculoskeletal imbalances, potentially resulting in chronic conditions such as herniated discs or sciatica. Given that military operators may be required to remain seated for long hours in confined spaces, the risk of lower back issues is notably increased.[7]

Hand-eye coordination fatigue

Constant reliance on fine motor skills and hand-eye coordination during FPV drone piloting can lead to fatigue in both the visual and motor systems. Pilots must synchronize hand movements with real-time video feedback, requiring intense concentration and precision. Over extended missions, this strain can lead to a decline in motor accuracy and slower reaction times, ultimately affecting mission success in high-pressure situations.[8]

Immersive disorientation (post-flight disconnection)

After extended periods of viewing the battlefield through FPV goggles, some operators may experience disorientation or difficulty reorienting themselves to their physical surroundings upon removing the headset. This condition, known as immersive disorientation, can result in dizziness or imbalance similar to post-flight vertigo, which may impair the pilot's physical or mental capabilities following prolonged missions.[9]

7 Galashevskyi, Hennadiy: *The importance of physical fitness of FPV drone operators in the process of performing combat tasks as intended,* 89.

8 Ge, X. et al.: *Influence of Head up Display on Visual Fatigue and Eye-Hand Discoordination in Runway Incursion Scenarios*, 44.

9 Souchet, A.D. et al.: *A narrative review of immersive virtual reality's ergonomics and risks at the workplace: cybersickness, visual fatigue, muscular fatigue, acute stress, and mental overload*, 21.

MENTAL HEALTH ISSUES

Beyond physical health challenges, FPV drone pilots are also vulnerable to a range of mental health issues due to the unique demands and stressors associated with operating in high-pressure environments. While physically distant from the battlefield, pilots face intense psychological challenges similar to those experienced by traditional combat personnel. Therefore, there is no relevant difference between drone operators and manned aircraft pilots, in relation to mental health issues.[10]

Cognitive overload

FPV drone piloting requires high levels of concentration and multitasking, as pilots must simultaneously control the drone, analyze real-time video feeds, and react to rapidly changing environments. The cognitive demand is exacerbated in military operations, where pilots are often required to make split-second decisions under extreme pressure. Studies indicate that such cognitive overload can lead to mental fatigue, reduced situational awareness, and slower reaction times, particularly during extended operations. Over time, this can impair decision-making and mission effectiveness, contributing to mental burnout.[11]

Simulator (VR) sickness

FPV drones immerse the pilot in a virtual environment through VR goggles, creating a disconnection between visual input and physical sensations. This sensory mismatch often leads to symptoms similar to motion sickness, such as nausea, dizziness, headaches, and disorientation, collectively referred to as "simulator sickness" or "cybersickness". Prolonged exposure to these environments can exacerbate symptoms, making it difficult for pilots to operate effectively, particularly in fast-paced, high-stakes tactical scenarios.[12]

Stress and anxiety

The high-stakes nature of military drone operations, including reconnaissance and strike missions, inherently generates significant stress. Pilots are responsible for critical tasks in hostile environments, where the risk of mission failure, equipment loss, or civilian casualties is ever-present. This heightened psychological pressure often leads to chronic stress and anxiety, which can have long-term

10 Otto, Jean L., Webber, Bryant J.: *Mental health diagnoses and counseling among pilots of remotely piloted aircraft in the United States Air Force*, 7.

11 Souchet, A.D. et al.: *A narrative review of immersive virtual reality's ergonomics and risks at the workplace: cybersickness, visual fatigue, muscular fatigue, acute stress, and mental overload*, 32.

12 Souchet, A.D. et al.: *A narrative review of immersive virtual reality's ergonomics and risks at the workplace: cybersickness, visual fatigue, muscular fatigue, acute stress, and mental overload*, 35–36.

negative impacts on both mental and physical health. Research shows that such stressors are comparable to those experienced by traditional combat pilots, despite the physical distance of drone pilots from the battlefield.[13]

Isolation and fatigue

Drone piloting often requires long hours of focused work in isolated environments, such as small, enclosed rooms or remote locations. The solitary nature of these tasks, coupled with the high concentration required, can lead to feelings of isolation and loneliness. Over time, this isolation may result in mental and emotional exhaustion, increasing the likelihood of burnout. Furthermore, the cumulative fatigue associated with prolonged focus can reduce operational performance, leading to slower reaction times and decision-making errors. Besides all that, ultra-long missions can also lead to circadian rhythm disruptions and sleep disorders.[14]

Decision fatigue

FPV drone operators are frequently required to make rapid, high-stakes decisions under pressure, particularly in combat scenarios. The constant need for precision and speed can lead to decision fatigue, where a pilot's ability to make effective choices deteriorates over time. This degradation in decision-making capacity can increase the risk of operational mistakes, particularly in prolonged missions where the mental strain is heightened.[15]

Post-traumatic stress disorder (PTSD)

Although FPV drone pilots are physically removed from the battlefield, they may still experience psychological trauma due to their role in combat operations. Research has shown that pilots involved in surveillance or strike missions may witness distressing events through the drone's live feed, leading to the development of PTSD symptoms similar to those experienced by ground-based combat personnel. Repeated exposure to traumatic imagery or the stress of making life-or-death decisions can contribute to emotional numbness, intrusive memories, and heightened anxiety.[16]

13 Otto, Jean L., Webber, Bryant J.: *Mental health diagnoses and counseling among pilots of remotely piloted aircraft in the United States Air Force*, 3.

14 Werner, Andreas et al.: *The New Quality of Aviation Unmanned Aerial Vehicles (UAV) Prevent Psychological Stress of Military Drone Operators*, 27.

15 Rahmani, Hoda, Weckman, Gary R.: *Working under the Shadow of Drones: Investigating Occupational Safety Hazards among Commercial Drone Pilots*, 60.

16 Lowe, Matthew, Gire, James T.: *In the mind of the predator: the possibility of psychological distress in the drone pilot community.*

Burnout

The combination of high-pressure environments, cognitive overload, isolation, and prolonged stress can lead to burnout among FPV drone pilots. Burnout not only affects mental health but also reduces operational performance by impairing a pilot's ability to concentrate and make sound decisions during missions. Studies indicate that the risk of burnout is particularly high among military drone operators engaged in repeated high-stakes operations without adequate rest or mental health support.[17]

CONCLUSION

FPV drones have rapidly transformed modern warfare, offering unprecedented advantages in battlefield intelligence, precision strikes, and situational awareness, as seen in the ongoing Russia-Ukraine conflict. Both sides have embraced these drones, recognizing their tactical value. However, the growing reliance on FPV drones introduces a range of physical and mental health risks to pilots, stemming from the unique demands of operating these systems through immersive FPV goggles and handheld controllers. The physical challenges, such as visual strain, repetitive motion injuries, and posture-related issues, alongside mental health risks, like cognitive overload, stress, and simulator sickness, present significant concerns for the long-term well-being of FPV drone operators. As military forces consider incorporating FPV drones into national defence strategies and potentially establishing dedicated FPV drone training programs, it is essential to acknowledge these health risks. Ensuring the physical and mental health of FPV drone operators is critical to maintaining operational effectiveness and the overall readiness of military personnel. Careful attention must be paid to designing training programs that incorporate health monitoring, preventive measures, and support systems to mitigate the risks. Only by prioritizing the well-being of drone operators can we fully harness the tactical potential of FPV drones while safeguarding the health and performance of those who control them. It is important to keep in mind that the poor physical and mental preparedness of operators increases the risk of accidents, which can result not only in financial loss but also in endangering civilians.

References

Galashevskyi, Hennadiy: *The importance of physical fitness of FPV drone operators in the process of performing combat tasks as intended*. Scientific Journal of National Pedagogical Dragomanov University, 6 (179), 2024, 85–90. Online: https://doi.org/10.31392/UDU-nc.series15.2024.6(179).16

Ge, X. et al.: *Influence of Head up Display on Visual Fatigue and Eye-Hand Discoordination in Runway Incursion Scenarios*. Human

17 Saini, Rajiv Kumar et al.: *Cry in the sky: Psychological impact on drone operators*, 17.

Error, Reliability, Resilience, and Performance, 33, 2022, 43–51. Online: https://doi.org/10.54941/ahfe1001566

Lowe, Matthew, Gire, James T.: *In the mind of the predator: the possibility of psychological distress in the drone pilot community.* Modern Psychological Studies, 17 (2), 2012, 2–7. Online: https://scholar.utc.edu/mps/vol17/iss2/2

Northey, G. W.: *The effects of stiffness and speed on upper limb electromyography during joystick use.* Doctoral dissertation, University of Guelph, 2004.

Otto, Jean L., Webber, Bryant J.: *Mental health diagnoses and counseling among pilots of remotely piloted aircraft in the United States Air Force.* Medical Surveillance Monthly Report, 20 (3), 2013, 3–8.

Ouyang, Xinli et al.: *Mechanisms of blue light-induced eye hazard and protective measures: a review.* Biomedicine & Pharmacotherapy, 130, 2020, 1–8. Online: https://doi.org/10.1016/j.biopha.2020.110577

Rahmani, Hoda, Weckman, Gary R.: *Working under the Shadow of Drones: Investigating Occupational Safety Hazards among Commercial Drone Pilots.* IISE Transactions on Occupational Ergonomics and Human Factors, 12 (1–2), 2024, 55–67. Online: https://doi.org/10.1080/24725838.2023.2251009

Rosenfield, Mark: *Computer vision syndrome: a review of ocular causes and potential treatments.* Ophthalmic Physiol Optics, 31, 2011, 502–515. Online: https://doi.org/10.1111/j.1475-1313.2011.00834.x

Saini, Rajiv Kumar et al.: *Cry in the sky: Psychological impact on drone operators.* Industrial Psychiatry Journal, 30 (1), 2021, 15–19. Online: https://doi.org/10.4103/0972-6748.328782

Souchet, A.D. et al.: *A narrative review of immersive virtual reality's ergonomics and risks at the workplace: cybersickness, visual fatigue, muscular fatigue, acute stress, and mental overload.* Virtual Reality, 27, 2023, 19–50. Online: https://doi.org/10.1007/s10055-022-00672-0

Szabó, Sándor András, Hornyik, József: *UAV (pilóta nélküli légijárművek) műveletek repülőegészségügyi feltételrendszerének biztosítása.* Repüléstudományi Közlemények, 26 (1), 2013, 61–77. Online: https://epa.oszk.hu/02600/02694/00061/pdf/EPA02694_rtk_2013_1_061-077.pdf

Werner, Andreas et al.: *The New Quality of Aviation Unmanned Aerial Vehicles (UAV) Prevent Psychological Stress of Military Drone Operators.* Clinical Medicine & Research, 9 (1), 2020, 25–30. Online: https://doi.org/10.11648/j.cmr.20200901.15

AZ FPV-DRÓNOPERÁTOROKAT ÉRINTŐ LEHETSÉGES EGÉSZSÉGÜGYI KOCKÁZATOK

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Kulcsszavak FPV-drón, pilóta, egészségügyi kockázat, VR, harctér

Absztrakt *Az FPV (belső látképes) drónok gyorsan a modern hadviselés kulcsfontosságú eszközeivé váltak, különösen a jelenleg is zajló orosz–ukrán konfliktusban való alkalmazásuk révén. A pontos csapások és a közvetlen helyzetfelismerés nyújtotta lehetőségek révén jelentősen átalakították a harctéri dinamikát. Az FPV-drónok bevetési*

száma folyamatosan emelkedik, ami alapot ad arra, hogy foglalkozzunk az elhúzódó és intenzív dróniránytásból fakadó egészségügyi kockázatok kérdésével. Az olyan problémák, mint a szemfáradás, kognitív túlterhelés és mozgásszervi panaszok különösen a hosszan tartó műveletek során jelentenek kihívást. Válaszul az FPV-dróntechnológia nemzetvédelmi stratégiákban betöltött növekvő szerepére, ez a cikk az FPV-drónpilótákra leselkedő egészségügyi kockázatokat igyekszik napvilágra hozni. Egy lehetséges FPV-drónpilótaképzési program bevezetése kapcsán fontos figyelembe venni, hogy a technikai feltételek megteremtése mellett az egészségügyi megelőző intézkedések meghatározása is szükséges a személyzet operatív felkészültségének és hosszú távú egészségének biztosítása érdekében.