

Skin Cancer in Military Pilots: A Special Population With Special Risk Factors



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PRACTICE POINTS

- Military and civilian pilots have an increased risk for melanoma and nonmelanoma skin cancer, likely due to unique occupational exposures.
- We recommend annual skin cancer screening for all pilots to help assess their individual risk.
- Pilots should be educated on their increased risk for skin cancer and encouraged to use sun-protective measures during their flying duties and leisure activities.

Military pilots may be at greater risk for skin cancer, particularly melanoma. Military-specific studies are limited, but skin cancer rates in civilian pilots and aircrews have previously been examined. Risk factors for all pilots may include exposure to UV radiation (UVR) at higher altitudes, cosmic radiation, and electromagnetic energy from cockpit instruments, as well as altered sleep-wake cycles. The study of aviation-specific risk factors for skin cancer is relevant to all pilots and dermatologists who care for them.

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Military dermatologists are charged with caring for a diverse population of active-duty members, civilian dependents, and military retirees. Although certain risk factors for cutaneous malignancies are common in all of these groups, the active-duty population experiences unique exposures to be considered when determining their risk for skin cancer. One subset that may be at a higher risk is military pilots who fly at high altitudes on irregular schedules in austere environments.

Through the unparalleled comradeship inherent in many military units, pilots “hear” from their fellow pilots that they are at increased risk for skin cancer. Do their occupational exposures translate into increased risk for cutaneous malignancy? This article will survey the literature pertaining to pilots and skin cancer so that all dermatologists may better care for this unique population.

Epidemiology

Anecdotally, we have observed basal cell carcinoma in pilots in their 20s and early 30s, earlier than would be expected in an otherwise healthy prescreened military population.¹ Woolley and Hughes² published a case report of skin cancer in a young military aviator. The patient was a 32-year-old male helicopter pilot with Fitzpatrick skin type II and no personal or family history of skin cancer who was diagnosed with a periocular nodular basal cell carcinoma. He deployed to locations with high UV radiation (UVR) indices, and his vacation time also was spent in such areas.² UV radiation exposure and Fitzpatrick skin type are known risk factors across occupations, but are there special exposures that come with military aviation service?

To better understand the risk for malignancy in this special population, the US Air Force examined the rates of all cancer types among a cohort of flying versus nonflying officers.³ Aviation personnel showed increased incidence of testicular, bladder, and all-site cancers combined. Noticeably absent was a statistically significant increased risk for malignant melanoma (MM) and nonmelanoma skin cancer (NMSC). Other epidemiological studies examined the incidence rates of MM in the US Armed Forces compared with age- and race-matched civilian populations and showed mixed results: 2 studies showed increased risk,^{4,5} while a third showed decreased

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risk.⁶ Despite finding opposite results of MM rates in military members versus the civilian population, 2 of these studies showed US Air Force members to have higher rates of MM than those in the US Army or Navy.^{4,6} Interestingly, the air force has the highest number of pilots among all the services, with 4000 more pilots than the army and navy.⁷ Further studies are needed to determine if the higher air force MM rates occur in pilots.

Although there are mixed and limited data pertaining to military flight crews, there is more robust literature concerning civilian flight personnel. One meta-analysis pooled studies related to cancer risk in cabin crews and civil and military pilots.⁸ In military pilots, they found a standardized incidence ratio (SIR) of 1.43 (95% confidence interval [CI], 1.09-1.87) for MM and 1.80 (95% CI, 1.25-2.80) for NMSC. The SIRs were higher for male cabin attendants (3.42 and 7.46, respectively) and civil pilots (2.18 and 1.88, respectively). They also found the most common cause of mortality in civilian cabin crews was AIDS, possibly explaining the higher SIRs for all types of malignancy in that population.⁸ In the United States, many civilian pilots previously were military pilots⁹ who likely served in the military for at least 10 years.¹⁰ A 2015 meta-analysis of 19 studies of more than 266,000 civil pilots and aircrew members found an SIR for MM of 2.22 (95% CI, 1.67-2.93) for civil pilots and 2.09 (95% CI, 1.67-2.62) for aircrews, stating the risk for MM is at least twice that of the general population.¹¹

Risk Factors

UV Radiation—These studies suggest flight duties increase the risk for cutaneous malignancy. UV radiation is a known risk factor for skin cancer.¹² The main body of the aircraft may protect the cabin's crew and passengers from UVR, but pilots are exposed to more UVR, especially in aircraft with larger windshields. A government study in 2007 examined the transmittance of UVR through windscreens of 8 aircraft: 3 commercial jets, 2 commercial propeller planes, 1 private jet, and 2 small propeller planes.¹³ UVB was attenuated by all the windscreens (<1% transmittance), but 43% to 54% of UVA was transmitted, with plastic windshields attenuating more than glass. Sanlorenzo et al¹⁴ measured UVA irradiance at the pilot's seat of a turboprop aircraft at 30,000-ft altitude. They compared this exposure to a UVA tanning bed and estimated that 57 minutes of flight at 30,000-ft altitude was equivalent to 20 minutes inside a UVA tanning booth, a startling finding.¹⁴

Cosmic Radiation—Cosmic radiation consists of neutrons and gamma rays that originate outside Earth's atmosphere. Pilots are exposed to higher doses of cosmic radiation than nonpilots, but the health effects are difficult to study. Boice et al¹⁵ described how factors such as altitude, latitude, and flight time determine pilots' cumulative exposure. With longer flight times at higher altitudes, a pilot's exposure to cosmic radiation is increasing over the years.¹⁵ A 2012 review found that aircrews have

low-level cosmic radiation exposure. Despite increases in MM and NMSC in pilots and increased rates of breast cancer in female aircrew, overall cancer-related mortality was lower in flying versus nonflying controls.¹⁶ Thus, cosmic radiation may not be as onerous of an occupational hazard for pilots as has been postulated.

Altered Circadian Rhythms—Aviation duties, especially in the military, require irregular work schedules that repeatedly interfere with normal sleep-wake cycles, disrupt circadian rhythms, and lead to reduced melatonin levels.⁸ Evidence suggests that low levels of melatonin could increase the risk for breast and prostate cancer—both cancers that occur more frequently in female aircrew and male pilots, respectively—by reducing melatonin's natural protective role in such malignancies.^{17,18} A World Health Organization working group categorized shift work as “probably carcinogenic” and cited alterations of melatonin levels, changes in other circadian rhythm-related gene pathways, and relative immunosuppression as likely causative factors.¹⁹ In a 2011 study, exposing mice to UVR during times when nucleotide excision repair mechanisms were at their lowest activity caused an increased rate of skin cancers.²⁰ A 2014 review discussed how epidemiological studies of shift workers such as nurses, firefighters, pilots, and flight crews found contradictory data, but molecular studies show that circadian rhythm-linked repair and tumorigenesis mechanisms are altered by aberrations in the normal sleep-wake cycle.²¹

Cockpit Instrumentation—Electromagnetic energy from the flight instruments in the cockpit also could influence malignancy risk. Nicholas et al²² found magnetic field measurements within the cockpit to be 2 to 10 times that experienced within the home or office. However, no studies examining the health effects of cockpit flight instruments and magnetic fields were found.

Final Thoughts

It is important to counsel pilots on the generally recognized, nonaviation-specific risk factors of family history, skin type, and UVR exposure in the development of skin cancer. Additionally, it is important to explain the possible role of exposure to UVR at higher altitudes, cosmic radiation, and electromagnetic energy from cockpit instruments, as well as altered sleep-wake cycles. A pilot's risk for MM may be twice that of matched controls, and the risk for NMSC could be higher.^{8,11} Although the literature lacks specific recommendations for pilots, it is reasonable to screen pilots once per year to better assess their individual risk and encourage diligent use of sunscreen and sun-protective measures when flying. It also may be important to advocate for the development of engineering controls that decrease UVR transmittance through windscreens, particularly for aircraft flying at higher altitudes for longer flights. More research is needed to determine if changes in circadian rhythm and decreases in melatonin increase skin cancer risk, which could impact

how pilots' schedules are managed. Together, we can ensure adequate surveillance, diagnosis, and treatment in this at-risk population.

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