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(Article begins on next page)



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The Risk of Melanoma in Pilots and Cabin Crew: UV Measurements in Flying Airplanes

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Recently, a meta-analysis reported an increased incidence of melanoma in pilots and cabin crew, which was possibly due to occupational exposures.¹ Cabin crews' exposure to cosmic radiation was assessed in different studies and always found below the allowed dose limit.² However, the cumulative exposure of pilots and cabin crew to UV radiation, a known risk factor for melanoma, has not been assessed to our knowledge.

Airplane windshields are commonly made of polycarbonate plastic or multilayer composite glass. UV-B (280–320 nm) transmission through both plastic and glass windshields was reported to be less than 1%. However, UV-A (320–380 nm) transmission ranged from 0.41% to 53.5%, with plastic attenuating more UV radiation than glass.³

Intrigued by our findings and the clinical observation of pilots developing melanomas on sun-exposed skin, we measured the amount of UV radiation in airplane cockpits during flight and compared them with measurements performed in tanning beds.

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Author Contributions: Drs Sanlorenzo and Ortiz-Urda had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Sanlorenzo, Ortiz-Urda.

Acquisition, analysis, or interpretation of data: All authors.

Drafting of the manuscript: Sanlorenzo, Vujic, Cleaver, Ortiz-Urda.

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Study supervision: Posch, Quaglino, Ortiz-Urda.

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Methods

UV radiation measurements were performed using a Solartech UV index meter designed to measure UV radiation from 280 to 400 nm (UV-B and UV-A) and a Solartech UV index meter designed to measure UV-B only (280–322 nm) (Solartech Inc). We first measured UV radiation in the pilot seat inside a general aviation turboprop airplane (Socata TBM850) through the acrylic plastic windshield (1.6-cm thick) at ground level and at 2500, 6000, 10 000, 15 000, 20 000, 25 000, and 30 000 feet above sea level. The measurements were taken in 2 locations with different solar exposures: San Jose, California, and Las Vegas, Nevada, around midday in April. Later, the same meters were used to measure UV radiation levels in an Omega UV-A tanning bed. The study design has been reviewed and approved by the Committee on Human Research, University of California, San Francisco.

Results

Our measurements inside the airplane revealed that the windshields blocked UV-B but allowed UV-A transmission. The amount of UV-A at 30 000 feet measured in Las Vegas, Nevada, was approximately 242 $\mu\text{W}/\text{cm}^2$ (Table 1). The UV-A dose in a UV-A-only tanning bed was 706 $\mu\text{W}/\text{cm}^2$. The carcinogenic effective dose was calculated using the Skin Cancer Utrecht–Philadelphia human action spectrum,⁴ and the dose for a 20-minute tanning session was 2940 mJ/m^2 . The carcinogenic effective doses of UV-A radiation in tanning beds and airplanes are compared in Table 2.

Discussion

The pathogenic role of UV-A in melanoma is well established. UV-A is capable of causing DNA damage in cell culture⁵ and in animal models.⁶ Pilots flying for 56.6 minutes at 30 000 feet receive the same amount of UV-A carcinogenic effective radiation as that from a 20-minute tanning bed session. These levels could be significantly higher when flying over thick cloud layers and snow fields, which could reflect up to 85% of UV radiation. Airplane windshields do not completely block UV-A radiation and therefore are not enough to protect pilots. UV-A transmission inside airplanes can play a role in pilots' increased risk of melanoma.

We recommend further studies to establish recommendations for occupation-related UV radiation dose limits. These studies should include more precise measurement in several airplanes. We believe that better UV protection on aircraft windshields is necessary to offer cabin crew a hazard-free work environment. We strongly recommend the use of sunscreens and periodical skin checks for pilots and cabin crew.

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Table 1

UV Measurements Performed at Pilot Seat Inside a Socata TBM850 at Different Altitudes

Altitude, ft	San Jose, CA (49 ft) ^a		Las Vegas, NV (2030 ft) ^a	
	UV-A and UV-B, $\mu\text{W}/\text{cm}^2$	UV-B only, $\mu\text{W}/\text{cm}^2$	UV-A and UV-B, $\mu\text{W}/\text{cm}^2$	UV-B only, $\mu\text{W}/\text{cm}^2$
Ground level	137	0	127	0
2500	135	0	128	0
6000	138	0	132	0
10 000	189	0	182	0
15 000	228	0	NA	0
20 000	234	0	212	0
25 000	250	0	210	0
30 000	NA	0	242	0

Abbreviation: NA, not available.

^aMeasurements in parentheses indicate height above sea level.

Table 2

UV-A Carcinogenic Effective Doses in Airplanes and in Tanning Beds

Location	Carcinogenic Effective Irradiance, mW/m ²	Time to Receive the UV-A Dose of a Tanning Bed Session, 2940 J/m ² , min
Inside tanning bed	2.45	20.00
In pilot seat at 30 000 ft	0.87	56.60

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