

# Beyond Ultraviolet (UV) Radiation: Occupational Hazards and Their Potential Synergistic Skin Effects on Flight Crew

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## BACKGROUND

Skin cancer in the general population is predominantly associated with UV radiation, yet the factors contributing to the twofold incidence of melanoma and non-melanoma skin cancer in pilots and cabin crew remain underexplored. Pilots and cabin crew are exposed to ionizing cosmic galactic and solar radiation, sleep disturbances, radioactive material transported as cargo and built into the airplane structure, electromagnetic fields, and pollution. Do these additional occupational hazards contribute to the increased incidence and mortality of skin cancer within the aviation industry?

## OBJECTIVE

This review aims to examine the occupational hazards of UVA radiation, ionizing cosmic radiation, radioactive material transported as cargo and built into the airplane structure, electromagnetic fields, altered circadian rhythms, pollution, and the potential synergistic effects of these factors on the skin of flight crew.

## METHODS

This systematic review encompasses a diverse range of studies, incorporating meta-analyses, cohort studies, and case-control studies. Within these, comparable populations sharing similar exposure rates and experimental data were utilized to illustrate the potential skin effects of various occupational hazards. Electronic databases were systematically searched using an extensive array of keywords and phrases. Studies revealing DNA damage, altered DNA repair mechanisms, and an elevated incidence of skin cancer were selectively included in this comprehensive review.

## RESULTS

Most UVB is blocked by the airplane window, however, in flight measurements of UVA at 30,000 ft. demonstrate that a 50-minute flight has the same UVA carcinogenic effect as a 20-minute tanning bed session.<sup>1,2,3</sup> UVA radiation, penetrating deep into the dermal stroma, generates reactive oxygen species, causing damage to DNA, the skin structure, and DNA repair mechanisms.<sup>4,5,6</sup>

The shielding effect from Earth's atmosphere diminishes with elevation, exposing flight crew to ionizing forms of cosmic radiation. The increased skin cancer incidence of flight crew parallels that of atomic bomb survivors, nuclear power plant workers, and medical radiation professionals, correlating with their shared exposure to low dose, long term radiation.<sup>7,8,9</sup> Additional radioactive exposure may occur through transported cargo, predominantly pharmaceuticals, and the aircrafts structure, in the form of depleted uranium ore.<sup>6</sup>

Circadian disruption can dysregulate the hypothalamic-pituitary-adrenal (HPA) axis, depleting melatonin - a potent antioxidant with receptors in the skin. Melatonin has been experimentally implicated in melanoma growth control and suppressing UV-induced skin damage.<sup>10</sup>

Substantially higher magnetic fields generated from aircrafts electrical systems raise concerns. Experimental data indicates that extremely low electromagnetic fields can sustain melanoma cells, while population studies demonstrate an association with malignant melanoma.<sup>11,12,13,14</sup>

Air pollution can affect Vitamin D synthesis, while defects contribute to melanomagenesis. Photo-pollution occurs when some pollutants are photo activated by UVA, thus inducing and exacerbating skin carcinogenesis.<sup>15,16</sup>

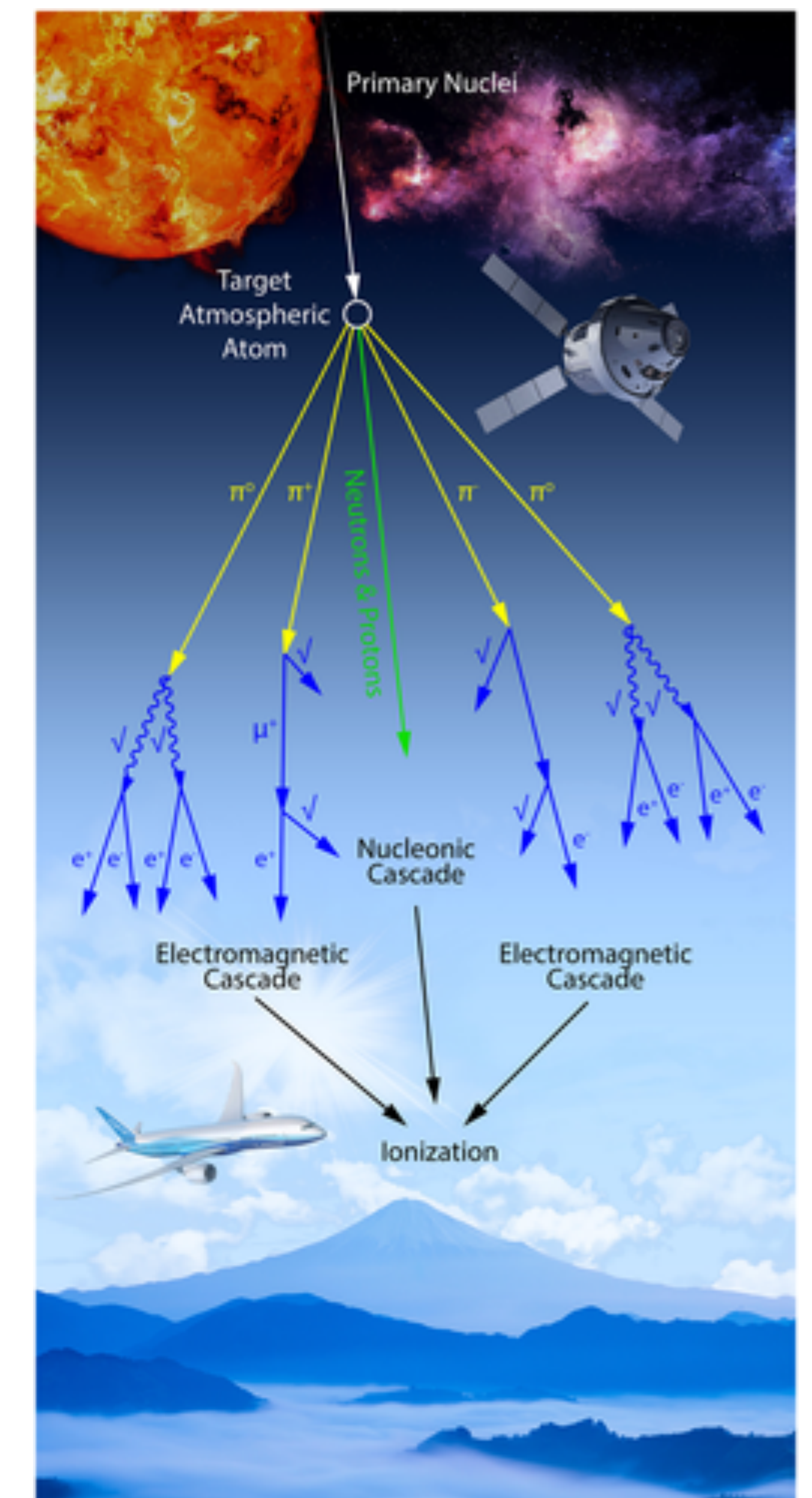
## CONCLUSION

UVA radiation, ionizing cosmic radiation, radioactive material in cargo/ airplane structure, electromagnetic fields, altered circadian rhythms, and pollution may contribute to the greater incidence of skin cancer amongst flight crew. This review lays the framework necessary for further research and prevention strategies for pilots and cabin crew.

## DISCLOSURES & ACKNOWLEDGEMENTS

Jennifer Raney, MD: Wulf Hess - Chief Innovation Officer. Tess Tarasen, BS: Wulf Hess - Chief Aviation Officer. Lesley Flynt, MD: Wulf Hess - Chief Nuclear Medicine Officer. Ashley Tarasen, MD: Wulf Hess - Medical Director.

## ILLUSTRATIONS



Categories of particle production in secondary atmospheric cosmic radiation per Overview of the Radiation Dosimetry Experiment (RaD-X) flight mission, utilizing measurements taken to determine human exposure to cosmic radiation in the aircraft environment.<sup>17</sup>

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