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SHORT REPORT

Predictors of skin cancer in commercial airline pilots

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Background Skin cancers among commercial airline pilots have been reported to occur at increased rates in pilot populations worldwide. The reasons for these increases are unclear, but postulated factors include ionizing radiation, circadian disruption and leisure sun exposure.

Aims To investigate the potential association of these occupational and lifestyle factors, as well as medical history and skin type, with non-melanoma skin cancer in pilots.

Methods Data were collected using a confidential Internet survey administered in collaboration with the Air Line Pilots Association International to all active pilots in four US commercial airlines. Pilots with non-melanoma skin cancer were compared to those without using multivariable analysis.

Results The response rate was 19%. Among pilots flying <20 years prior to diagnosis, factors associated with increased odds of non-melanoma skin cancer were at-risk skin type, childhood sunburns and family history of non-melanoma skin cancer. Off-duty sunscreen use and family history of melanoma were protective. Among pilots with ≥20 years flight time prior to diagnosis, childhood sunburns and family history of non-melanoma skin cancer persisted as risk factors, with the addition of flight time at high latitude.

Conclusions Further investigation regarding the potential health impact of long-term flying at high latitudes is recommended. Additionally, occupational health programmes for pilots should stress awareness of and protection against established risk factors for non-melanoma skin cancer.

Key words Aviation; epidemiological studies; skin cancer.

Introduction

Skin cancers among commercial airline pilots have been reported to occur at increased rates in pilot populations worldwide [1–4]. The reasons for these increases are unclear, but postulated factors include ionizing radiation [1–3], circadian disruption [4] and leisure sun exposure [1–4]. The purpose of this study was to investigate the potential association of these occupational and leisure sun exposures, as well as medical history and skin type, with skin cancer in commercial airline pilots. Because non-melanoma skin cancers occur much more frequently than melanoma, this report focuses on non-melanoma skin cancers.

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Methods

This study was approved by the Medical University of South Carolina Institutional Review Board and conducted in collaboration with the Air Line Pilots Association International (ALPA) using a confidential Internet survey hosted on a secure ALPA Website. All active pilots in four US-based airlines (passenger and cargo pilots, including those on sick leave) were invited to participate through email notification with email reminders sent directly from ALPA.

Survey topics addressed medical history, leisure sun exposure, occupational and medical radiation exposure and circadian disruption. Specific information collected included the following: skin type, hair/eye colour, family history of skin cancer, dysplastic naevi/numerous moles, weakened immune system (AIDS or immunosuppressive drugs), location of skin cancer on the body, race/ethnicity, gender, year of birth, sunscreen use, sunburn history, tanning bed use, time outdoors during peak sun hours (10.00 a.m. to 4.00 p.m.), use of protective clothing, total flight time, flight time at high altitude (≥40 000 feet), flight time at high latitude (above 55 N or below 55 S), flying

in night conditions at current location, flying when departure time is night at home base (6.00 p.m. to 6.00 a.m.), crossing five or more time zones in a single-duty period, number >24-h awake duty periods per month (not including inability to sleep before or after duty period) and melatonin usage. Skin Cancer Foundation criteria [5] were used to define an at-risk skin type variable based on eye and hair colour, skin type and ease of burning. All pilots, regardless of cancer status, reported exposure information for the nearest 'at-risk' year (the most recent year without any skin cancer).

Multivariable logistic regression models predicting non-melanoma skin cancer were developed according to standard statistical methods [6] within each of two flight time strata based on median flight time to diagnosis (<20 years, ≥20 years). Within each stratum, any variable associated with non-melanoma skin cancer in a univariable model at the 0.15 alpha level was included in the multivariable model (the age variable tested was age at start of flying). Multicollinearity and log odds linearity assumptions were checked; variables were dichotomized at the median value if the log odds assumption was violated. Backward stepwise logistic regression removed variables meeting the exclusion criterion alpha >0.05, producing a final model of independent variables associated with non-melanoma skin cancer. Hosmer and Lemeshow's goodness of fit statistic was also estimated for final models.

Results

The response rate was 19% (2865 of 15 331). Twelve subjects were excluded due to a diagnosis of skin cancer prior to the start of their flying career, 146 for completely missing out exposure or flight time information on the questionnaire and 95 who actually had a melanoma. Because 93% of respondents were non-Hispanic white males, results are presented only for this group. Of 2428 non-Hispanic white male respondents, 462 (19%) reported having had non-melanoma skin cancer, with the median flight time prior to diagnosis being 20 years. Of the 1963 pilots who had never had a skin cancer of any type, 611 had <20 years flying experience and 1352 had ≥20 years. Within the <20 years stratum, variables meeting the multivariable entry criterion were age at start of flying, number of severe sunburns in the prior year, off-duty sunscreen use, flying when departure time is night at home base, crossing five or more time zones in single duty, melatonin usage, at-risk skin type, repeated severe childhood sunburns, family history of melanoma and family history of non-melanoma skin cancer. Results of the backward selection model with the best goodness of fit statistic are summarized in Table 1. Within the ≥20 years stratum, variables meeting the multivariable entry criterion were tanning bed hours/week, off-duty sunscreen use, flight time at high latitude (ever versus never), crossing five or more time zones in single duty, repeated severe childhood sunburns and family history of non-melanoma skin cancer. Results of the backward selection model are summarized in Table 2.

Discussion

Our results suggested that factors associated with increased odds of non-melanoma skin cancer among pilots flying <20 years were at-risk skin type, childhood sunburns and family history of non-melanoma skin cancer. Off-duty sunscreen use and family history of melanoma were protective. Among pilots with ≥20 years flight time prior to diagnosis, childhood sunburns and family history of non-melanoma skin cancer persisted as risk factors, with the addition of flight time at high latitude.

Skin type, sun exposure [ultraviolet (UV)] and family history are frequently cited risk factors for non-melanoma skin cancer in the general population [5]; however, the increased odds associated with high latitude among pilots flying for ≥20 years prior to diagnosis may be specific to this occupational group. Increasing latitude is associated with decreasing UV radiation [5], with UV exposure at flight altitudes reported to be small due to shielding by the aircraft windshield [7]. In contrast, increasing latitude is associated with increasing ionizing radiation (the same is true of increasing altitude across the typical flight range) [8]. At flight altitudes, exposure to ionizing radiation over the geomagnetic poles is about

Table 1. Odds ratios (ORs) and 95% confidence intervals (CIs) for independent risk factors associated with non-melanoma skin cancer for flight time prior to cancer <20 years

Flight time < 20	OR (95% CI)
Off-duty sunscreen use	0.6 (0.4–0.8)
At-risk skin type	3.2 (2.0–5.2)
Childhood sunburns	2.1 (1.5–3.0)
Melanoma family history	0.2 (0.1–0.3)
Non-melanoma family history	8.6 (5.8–12.7)

Goodness of fit $P = 0.4$.

Table 2. Odds ratios (ORs) and 95% confidence intervals (CIs) for independent risk factors associated with non-melanoma skin cancer for flight time prior to cancer ≥20 years

Flight time ≥20	OR (95% CI)
Childhood sunburns	1.6 (1.2–2.2)
Flight time at high latitude	1.4 (1.0–1.9)
Non-melanoma family history	4.1 (3.0–5.7)

Goodness of fit $P = 0.3$.

twice that over the geomagnetic equator [8]. Given that ionizing radiation has been associated with non-melanoma skin cancer [9], this finding warrants further study.

A strength of this study is the use of multivariable analysis. Other studies have reported increased skin cancer among pilots but have not rigorously examined statistically associated factors. Limitations are those related to the cross-sectional design, primarily the use of prevalent/ever cases, recall bias, the potential loss of cases due to early retirement or death, self report and non-response. The low response rate (19%), though consistent with rates for web-based surveys [10] and ample for valid analysis of the responding group, limits generalization beyond that group.

In conclusion, occupational health programmes for pilots might benefit from (i) stressing awareness of modifiable risk factors for non-melanoma skin cancer and (ii) further investigating the potential health impact of long-term flying at high latitudes.

Key points

- Among pilots flying <20 years prior to diagnosis, factors associated with increased odds of non-melanoma skin cancer were at-risk skin type, childhood sunburns and family history of non-melanoma skin cancer.
- The use of off-duty sunscreen and a family history of melanoma were associated with reduced odds of non-melanoma skin cancer among pilots flying <20 years prior to diagnosis.
- Among pilots with ≥20 years flight time prior to diagnosis, childhood sunburns and family history of non-melanoma skin cancer persisted as risk factors, with the addition of flight time at high latitude.

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Conflicts of interest

None declared.

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