Do Airline Pilots and Cabin Crew Have Raised Risks of Melanoma and Other Skin Cancers?

Discussion

This review of all relevant published studies suggests that airline pilots have about twice the risk of melanoma and of keratinocyte skin cancers than the general population. They also appear to be at greater risk of dying from melanoma but not KC compared with the population at large. Given that solar UV radiation is the main environmental cause of melanoma and KC, these data appear to implicate occupational exposure to UV as a cause. UV is undetectable in the cabins of modern airliners, and levels in flight decks are either undetectable or not increased above ground-level values.[36] However, this might not have been the case for airliners operating in the last century, when UVA levels on airline flight decks might have been increased.[37] However, we found that almost all of the relevant published evidence is out of date and reflects the circumstances and patterns of behaviour of pilots and cabin crews in the mid-to-late twentieth century rather than those of today's pilots and cabin crews.

Despite this, the risk of melanoma and KC among cabin crew is raised to the same degree as that in pilots and, consequently, occupational exposure to increased levels of UV radiation is unlikely to explain our findings. Both pilots and cabin crew experience disruption of circadian rhythm on long-haul routes. Although this is known to be carcinogenic in experimental animals, evidence is more limited in humans.[30] Moreover, much of the information about

cancer incidence in airline pilots has accrued from pilots flying short-haul routes. Consequently, circadian disruption seems unlikely to explain our findings. Diagnostic bias due to regular clinical surveillance could contribute to the raised incidence of melanoma and BCC in pilots and cabin crew; however, this would not be expected to be associated with increased melanoma mortality.

Exposure to cosmic radiation is elevated in both pilots and cabin crew, although dosimetry shows annual exposure to be below levels currently thought to be hazardous,[38] including to the skin.[39] Although melanoma is a cancer with very low sensitivity to induction by ionizing radiation,[40] and consequently is not included among cancers attributed to ionizing radiation in systematic reviews,[41] 'safe doses' regarding induction of melanoma have not been precisely defined and so current occupational dose limits could not be set specifically to minimize melanoma risk. Moreover, the U.S. National Council on Radiation Protection and Measurements shows that pilots have the largest average annual effective dose of all radiation-exposed workers in the U.S.A.[42] The data showing a linear relationship between melanoma risk (but not melanoma mortality) and longer duration of employment, greater radiation exposure and longer world flights are in keeping with this notion, and should be explored further.

The alternative explanation for the raised risks of melanoma and KC in pilots and cabin crew is recreational exposure to solar UV radiation during recreational activities including during stopovers at final destinations. UV is believed to be the cause of melanoma in white populations living at all latitudes,[43] including most of the melanoma in those living at northern latitudes, where all published studies regarding melanoma in pilots to date have been undertaken.[44] However, there is no direct evidence to show that airline pilots

and cabin crew have increased recreational UV radiation exposure. In particular, increased UV radiation exposure during stopovers is not supported by evidence, and many professional pilots consider it improbable (K. Burnham and G. Cruse, personal communication). Moreover, many of the sectors and destinations included in the published studies were at medium and high latitudes.

A previous systematic review[5] also found a doubling of rates of melanoma in pilots and cabin crew compared with the general population, although this was based on a pooled dataset for pilots that differed from the present pooled data. The earlier review included studies of both military and airline pilots[45,46] and one without histologically confirmed disease,[47] as well as four study populations[48–51] that had been covered by the single pooled study of melanoma incidence in national cohorts of pilots from Denmark, Finland, Iceland, Norway and Sweden.[26] For the melanoma SMR we included a new study,[23] namely a pooled study of melanoma mortality in cohorts of airline pilots and cabin crew from Denmark, Finland, Germany, Greece, Iceland, Italy, Norway, Sweden, the U.K. and the U.S.A., which replaced several previously included studies.[28,31,34,52] Finally, the previous review[5] assessed melanoma only, while we additionally assessed other skin cancers.

There was no evidence of publication bias assessed by Begg's and Egger's tests (all $P > 0.05$). Nonetheless, the tests are likely to be underpowered due to the small number of studies included in this meta-analysis, and the results should be interpreted with caution. Furthermore, the included number of studies for the meta-analysis is small, although three of 12 were large pooled studies. With the exception of melanoma incidence in pilots, four studies or fewer were included in the meta-analyses and this may have limited our ability to estimate heterogeneity accurately. Although we did not

detect heterogeneity, neither did we assume homogeneity, and we used random effects models to account for between-study variance.

In this review we did not include unpublished literature such as conference abstracts. However, these sources are often preliminary, final results can change, and unpublished literature is not peer reviewed. A major limitation of this review is the lack of contemporary evidence: two large pooled incidence studies included data from as far back as 1947, and almost all of the data were collected at least 2–3 decades ago. Thus, the available evidence has uncertain relevance to today's airline flight crews, whose occupational circumstances and recreational patterns are different from those of 20–70 years ago. Furthermore, European study populations predominate as the basis of available datasets. One New Zealand study was excluded because the measure of melanoma occurrence was self-reported lifetime prevalence,[6] and so there were no studies from Australasia and relatively few from North America to round out the evidence base, leaving it deficient in coverage of melanoma risk in pilots from highly susceptible white-skinned populations.

In summary, this review of all available evidence suggests that airline pilots and cabin crew are at twice the risk of melanoma and keratinocyte skin cancers as the general population, and also that pilots are at raised risk of death from melanoma. However, the bulk of the relevant evidence is out of date as it collectively reflects the circumstances and patterns of behaviour of pilots and cabin crews in the mid-to-late twentieth century. Ionizing radiation exposure remains a plausible cause, and there is an urgent need for contemporary research on this topic.

Background: Airline pilots and cabin crew are potentially exposed to hazardous ultraviolet and cosmic radiation, which may increase their risk of melanoma and other skin cancers.

Objectives: To establish precise risks of melanoma and keratinocyte cancer (KC) for airline pilots and for cabin crew based on all studies published to date.

Methods: We searched MEDLINE, ISI Science Citation Index, Embase, SCOPUS and CINAHL to June 2018. All studies of melanoma and KC risk and mortality in airline pilots and cabin crew compared with the general population were eligible. Standardized incidence ratios (SIRs) and standardized mortality ratios (SMRs) were pooled using random effects models.

Results: From 5866 papers retrieved, we reviewed 44 full-text articles, of which 12 studies with data collected mostly between the 1970s and 1990s were eligible for inclusion. The pooled SIR (pSIR) for melanoma in pilots was 2.03 [95% confidence interval (CI) 1.71–2.40] and in cabin crew it was 2.12 (95% CI 1.71–2.62). For pilots, the pooled SMR for melanoma was 1.99 (95% CI 1.17–3.40) and for cabin crew it was 1.18 (95% CI 0.73–1.89). For KC, the pSIR was 1.86 (95% CI 1.54–2.25) in pilots and 1.97 (95% CI 1.25–2.96) in cabin crew. There was no evidence of study heterogeneity.

Conclusions: The available evidence shows that airline pilots and cabin crew have about twice the risk of melanoma and other skin cancers than the general population, with pilots more likely to die from melanoma. However, most of the evidence was collected several decades ago and their relevance to contemporary levels of risk is uncertain.

Introduction

Airline pilots enjoy substantially better health than the general population: they undergo regular medical examinations and have higher than average socioeconomic status.[1] Despite a lower risk of some cancers,[2,3] airline pilots appear to be at significantly increased risk of developing and dying from melanoma.[4–7] A recent survey reported that melanoma rates among airline pilots were about 50 times higher than those of the general adult population (19 vs. 0.4 per 1000).[6] Specific occupational causes such as increased exposure to cosmic ionizing radiation[8] and ultraviolet (UV) radiation[9] and circadian rhythm disruption[10] are plausible explanations.

Cabin crew are exposed to the same levels of cosmic radiation as pilots and experience the same disruption of circadian rhythm, but they are not likely to be occupationally exposed to UV radiation. A recent meta-analysis of published studies of airline pilots and/or cabin crew reported double the incidence of melanoma in both pilots and cabin crew compared with the general population, with standardized incidence ratios (SIRs) of 2.22, 95% confidence interval (CI) 1.67–2.93 and 2.09, 95% CI 1.67–2.62, respectively.[5] In addition, the standardized mortality ratio (SMR) for melanoma was significantly raised among pilots (SMR 1.83, 95% CI 1.27–2.63) but not among cabin crew (SMR 0.90).[5] However, this analysis included studies of aviation warfare system operators and military pilots as well as nonairline commercial pilots flying short sectors at lower altitudes. Melanoma was not histologically confirmed in all included studies. Data about risk of keratinocyte cancers (KCs) in airline pilots show conflicting results.[2,11,12]

Because of uncertainty about melanoma and KC risk in airline pilots, we undertook a systematic review and meta-analysis of all relevant studies published to date. We also systematically reviewed all

published studies and pooled the risk estimates of melanoma in cabin crew as a comparison group. Finally, to supplement these data, we reviewed the published evidence on KC risk in both airline pilots and cabin crew compared with the general population. All studies included were of histologically confirmed melanoma and KCs. As hazardous occupational UV exposure would be restricted to the flight deck and therefore would affect only pilots, we hypothesized that their risk of melanoma and KC compared with the general population would be increased more than the corresponding risk of melanoma and KC seen in cabin crews.