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Cancer Awareness Among Airline Pilots

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Abstract

A high level of cancer awareness may contribute to early diagnosis and improve cancer survival. This study is aimed to assess the level of awareness of occupational cancer among airline pilots. To the best of the authors' knowledge, this study has examined pilots' occupational cancer awareness levels for the first time. A brand-new cancer awareness survey was used to examine the awareness level of airline pilots on cancer. The analysis of variance (ANOVA) method was employed to analyze the survey results. The response rate was % 43.6. Data had been collected from 523 individuals, 48 of whom were female pilots. Of the participants 67.3% were long-haul pilots. Female airline pilots were much more aware of cancer in comparison to male airline pilots. Pilots flying 81-90 hours per month were much more aware of cancer in comparison to other participants. Academic articles, magazines and social media were sources of knowledge for 64.6 % of pilots whereas 39.5% of pilots were informed by e-learnings and recurrent trainings regarding the occupational cancer. According to the findings of this study, there is a need for training and media-based interventions to raise awareness and instil safe and healthy lifestyle practices at the workplace in the airline industry.

1. Introduction

Cancer is a major area of interest within the field of occupationally related diseases. Occupational diseases have been extensively examined for decades (Şen et al., 2019). The term "De morbis artificium diatriba" (Diseases of workers) was first introduced by Bernardino Ramazzini in 1700 (Ramazzini, 2001). After that, a great number of studies have been carried out on this particular subject (Van Tongeren et al., 2012).

In 1775, Percival Pott reported the first occupational cancer (Herr, 2011). Aircrews, miners and quarry and construction workers are among the high-risk occupations which are exposed to work related carcinogens.

Cancer is one of the most common causes of mortality among pilots and incidence is increasing worldwide (Hammer et al., 2012; Bagshaw & Cucinotta, 2008). Incidence studies suggest that cancer is accounted for a larger mortality among United States commercial pilots. It has been reported that airline crew in Germany had the highest radiation exposure among the occupational groups (Wollschläger et al., 2018). Moreover, a considerable amount of literature has been published on cancer incidence among airline pilots from several European countries (Irvine & Davies, 1999; Haldorsen et al., 2000; Hammer et al., 2012) and Japan (Kaji et al., 1993). It has been reported that three most common cancers among airline pilots are skin cancer, prostate cancer and brain cancer (Gudmundsdottir et al., 2017).

Medical status of pilots is of great importance for safe piloting to ensure the maintenance of aviation safety (Kilic, 2021). Airline pilots are occupationally exposed to specific occupational risk factors (carcinogens) such as cosmic radiation, circadian dysrhythmia, non-ionizing radiation, electromagnetic fields and jet fuel combustion products (McCartney et al., 1986) potentially leading to cancer (Raslau et al., 2016).

Cosmic radiation is an ionizing radiation originates outside the solar system and interacts with the earth's atmosphere (ICAO, 2012). Airline pilots are exposed to elevated levels of radiation (cosmic galactic radiation) at aircraft cruising altitudes in comparison to the exposure at sea level (Bagshaw & Illig, 2018). It has been reported that the highest radiation dose levels were measured on polar routes and at high altitudes (Langner et al., 2004). Hammer et al reported that there was a positive trend of all cancer with radiation dose (Hammer et al., 2012).

Low-frequency electromagnetic fields in the cockpit is one of the environmental factors which may be attributed to cancer (Nicholas et al., 1998). This electromagnetic field is generated by the aircraft's electrical system. It has been suggested that there may be an association between electromagnetic field exposure and reduced melatonin level (Stevens et al., 1992) which is known for impeding prostate cancer metathesis (Wang et al., 2020).

Non-ionizing radiation is known as a series of energy waves such as ultraviolet radiation from sunlight, infrared radiation from mobile phones, radiofrequency and microwave

radiation, extremely low frequency radiation from electrical equipment and electrical wiring (United States Department of Labor, 2021). Exposure to non-ionizing radiation may give rise to serious burns, permanent eye damages (e.g., cataracts), and malignant diseases (e.g., skin cancer)(Dyro & Morris, 2004; Cadilhac et al., 2017).

Disruption of circadian rhythms is one of the most important factors causing fatigue among pilots (Goffeng et al., 2019) and has been associated with several types of cancer (Cadilhac et al., 2017).

Pilots operating long-haul aircraft are exposed to time zone displacements and disturbed sleep which might impede their performance and cause insomnia (Gander et al., 2014). Furthermore, the International Agency for Research on Cancer (IARC) described the circadian rhythm disruption as a potential carcinogenic to humans (WHO-International Agency for Research on Cancer, 2010)

Jet fuel combustion products are among the occupational risk factors and they contain carcinogenic compounds including polycyclic aromatic hydrocarbons (Ritchie et al., 2003). It has been reported that exposure to kerosene type fuel (aviation fuels), which is widely used in civil aviation, may cause cancer (Siemiatycki et al., 1988).

Smoking (Carbone, 1992), imbalanced diet (Key et al., 2020), and recreational sun exposure (Newman et al., 1996) are among the factors associated with cancer. It has been reported that smoking, including passive exposure gives rise to 80% of lung cancer (Alberg & Samet, 2003). Previous studies on pilot have reported that smoking prevalence among pilots are predominant (Ahsan MA et al., 2016) (Hall et al., 2018). However, other researchers have reported that the prevalence of smoking among pilots is lower than smoking prevalence in Swedish normal population (Lindgren et al., 2008). Several studies highlighted that there were strong correlations between several types of cancer and dietary factors (Armstrong & Doll, 1975). A number of studies have reported that there was a strong association between recreational sunburn and risk of skin cancer (Oliveria et al., 2006).

Piloting profession is a sedentary occupation. Long-term sitting in the cockpit may give rise to sorts of problems such as venous thromboembolism (Kilic & Soran, 2020), back strain (Rodriguez & Ortiz Mayorga, 2016), and colon cancer (Garabrant et al., 1984). Another important factor associated with cancer is the duration of the employment. It was shown that there was a positive correlation between the duration of employment and cancer (Hammer et al., 2014).

A great number of airlines launched cancer awareness campaigns and raised money to support cancer research projects. For instance, each October, Delta airlines hosts its annual campaign to encourage employees to generate cancer awareness and support breast cancer research fundraising (Staff Writer, 2021). Cargolux Airlines participated in the Fly Pink fundraising initiative (Rachelle Harry, 2019).

Although extensive research has been carried out on cancer incidence among pilots, no single study exists which examine cancer awareness of airline pilots. With these consideration in mind, the aim of this study is to investigate the awareness level of airline pilots on cancer and occupational risk factors.

Based on the issues mentioned above, we offered the following hypotheses. The first hypothesis proposed that the awareness level of airline pilots on occupational cancer may vary based on the demographics. The second hypothesis was "the effort of airline pilots to be informed on occupational cancer may vary based on demographics." The third hypothesis proposed that the risk factors of occupational cancer for airline pilots may vary based on the demographics.

2. Materials and Methods

2.1. Subjects

The study sample consisted of 523 airline pilots from 5 different airline companies, all based in Turkey. Participation in this study was voluntary and unpaid. The majority of the subjects (59.7%, *N*= 312) were airline captains. Of the respondents, 29.4% (*N*=154) were first officers and 10.7% (*N*=56) senior first officers (cruise relief pilots). Of the participants, 475 (90.8%) were men and 48 (9.2%) were women. Approximately, one half of the participants had more than 20 years flight experience. Almost two-thirds of the participants (68.1%, *N*=352) fly long-haul aircrafts (e.g., Boeing 777,787, 777-Freighter, Boeing 747, Airbus A330, Airbus 340 and Airbus 350). 9,9% of those who were interviewed (*N*=52) were 20-30 yr of age, 40% (*N*=209) of the participants were 31–40 yr of age, (*N*=134) of the participants were 41-50 yr of age, and 24.5% (*N*=128) of the subjects were older than 50.

2.2. Survey

The questionnaire was developed based on input from field experts and the research literature on occupational cancer and aviation medicine. Cronbach's alpha test was performed to test the reliability of 13 expressions and factor analysis was used to determine the consistency. The questionnaire was distributed online to 1200 airline pilots who are based in Turkey. 523 of them responded to the questionnaires. The response rate was % 43.6. The questionnaire consisted of 20 items and 4 sections. The first section consists of questions regarding the demographics of subjects, such as gender, age, total flying experience, ranking, current type rating (Questions 1-6). In the second part, the participants were asked whether they had been informed about occupational cancer through e-learnings and recurrent trainings, whether they had read books, academic articles, and magazines on the subject and whether they had used of social media as an informative source were questioned (Questions 7 and 8). In the third section, eight items were used to assess the awareness level of participants on occupational cancer and carcinogens (Questions 9-16,20). The final section of the questionnaire asked if they wear sunscreen in the cockpit, can maintain a balanced diet during the flight and layover and smoke cigarettes were questioned (Questions 18 and 19). The participants answered the questions on a 5-point Likert-type scale that ranges from "1- strongly disagree" to "5- strongly agree".

2.3. Statistical analysis

Data analyses were performed using SPSS (the Statistical Package for the Social Sciences) for Windows 24.0. Kolmogorov-Smirnov test was performed to examine the compliance of the parameters with normal distribution. A one-way ANOVA was used to assess the results of the survey. Prior to ANOVA test, the Levene's test was conducted to test the equality of variances. For unequal variances, the Tamhane T2 test was performed. The Bonferroni correction was used for equal variances. A 95% confidence interval and a significance level of $P< 0.05$ were used for the interpretation of the results.

3. Result and Discussion

The results revealed that pilots had little knowledge of occupational cancer. Of those participants, 45.5% (N=238) reported that they could maintain a balanced diet during the flight and layover. Almost half of the respondents (47.6%, N=249) indicated that they did not wear sunscreen in the flight deck. The results are in the line of earlier literature that found a minority of airline pilots (14%1) use sunscreen (Yong et al., 2022). Of those respondents, 45.7% (N=239) reported that they smoked cigarettes The finding is consistent with findings of past studies by Ahsan et al. which found almost half of the pilots (42%) were smokers (Ahsan MA et al., 2016). A minority of participants (20.1%, *N*=105) indicated that they had been informed about occupational cancer by e-learning and recurrent trainings. Approximately one-third of those surveyed (30%, N=157) said that they read books, academic articles, and magazines about occupational cancer and follow the topic on social media.

The most striking results from the data is that 68.2% (N=357) of those questioned were aware of the recreational sun exposure (during the holidays and layovers) which accounts for many acute and chronic dermatological diseases, including skin cancer.

Table 1. Study results based on the demographic factors

		Risk Factors			Awareness			Information Sources		
	N	Mean	F	P	Mean	F	P	Mean	F	P
Gender										
Male	475	3.211	10.526	0.001	3.400	4.352	0.037	2.598	3.469	0.063
Female	48	3.677			3.648			2.844		
Age										
20-30 years old	52	3.663	6.192	0.000	3.483	1.291	0.277	2.750	10.208	0.000
31-40 years old	209	3.093			3.398			2.488		
41-50 years old	134	3.216			3.344			2.459		
51 or older	128	3.387			3.522			2.953		
Rank										
Senior First Officer	56	2.973	3.292	0.038	3.387	0.698	0.498	2.482	1.589	0.205
Commander	312	3.253			3.456			2.673		
First Officer	155	3.355			3.369			2.565		
Experience										
Less than 5 years	78	3.474	2.822	0.025	3.353	1.243	0.292	2.776	6.108	0.000
5 to 10 years	157	3.073			3.345			2.347		
11 to 15 years	42	3.369			3.389			2.833		
16 to 20 years	32	3.406			3.573			2.594		
More than 20 years	214	3.259			3.490			2.727		
Aircraft Type										
Long haul	352	3.220	1.110	0.293	3.435	0.471	0.493	2.588	0.661	0.416
Short haul	165	3.315			3.384			2.655		
Flying in a month										
Up to 60 hours	85	3.094	2.567	0.054	3.169	7.085	0.000	2.371	3.669	0.012
61-70 hours	210	3.274			3.427			2.612		
71-80 hours	180	3.222			3.435			2.694		
81-90 hours	48	3.563			3.810			2.823		

Based on the findings illustrated in Table I, there was a significant difference between male and female participants. Female pilots were found to be much more aware about cancer than male pilots. There were no significant differences in the awareness levels of participants based on their age (e.g., 20-30 years old, 31-40 years old, 41-50 years old, and 51 or older), total flying experience (e.g., less than 5 years, 5-10 years, 11-15 years, 16 to 20 years, more than 20 years), ranking (e.g., commander, senior first officer, first officer), and type of aircraft (e.g., long-haul and short-haul). As shown in Table 1, pilots flying 81-90 hours in a month were much more aware than those among the remaining participants. These findings provided support for our first hypothesis.

Based on the results of one-way ANOVA, there was a significant difference in the effort of participants to get information on occupational cancer (reading newspaper, magazines and following social media sources) based on their age (e.g., 20-30 years old, 31-40 years old, 41-50 years old, and 51 or older). It was found that pilots aged 51 and older made much more effort to keep themselves informed about occupational cancer than pilots aged 31-40 and 41-50. According to the results of the one-way ANOVA, there was no significant difference in the mean results of informative sources based on ranking of pilots (e.g., commander, senior first officer, first officer) and type of aircraft (e.g., long-haul and short-haul) ($P > 0.05$). Interestingly, there were significant differences in the efforts of participants to be informed about occupational cancer based on their total flying experience (e.g., less than 5 years, 5-10 years, 11-15 years, 16 to 20 years, more than 20 years). Pilots with 5-10 years of flying experience made much less effort to get information about occupational cancer than experienced pilots. These findings provided strong support for the second hypothesis “the effort

of airline pilots to be informed on occupational cancer may vary based on demographics.

The results, as shown in Table I, indicated that female airline pilots were much more aware of the risk than male airline pilots. It was also shown that there were significant differences in the risk level of participants based on their age, ranking, flying experience. Pilots in the 20-30 age group at greater risk in comparison to pilots in the 31-40 and 41-50 age groups. On the other hand, pilots aged 51 and older exhibited more risk than pilots in the 31-40 age groups. First officers were at greater risk than senior first officers. There was no significant difference in the risk level between commanders and first officers. Pilots with less flying experience (e.g., less than 5 years) were found at greater risk compared to pilots with flying experience of 5 to 10 years. Furthermore, there was no significant difference in the risk level of participants based on the type of aircraft (e.g., long-haul and short-haul).

The current study found that the awareness level of airline pilots was low. It is interesting to note that the awareness levels of pilot flying 81-90 hours in a month higher than those among the pilots flying less than 80 hours in a month.

Contrary to expectations, the older pilots (51-65) were much more interested in getting information on occupational cancer than the younger pilots. One possible explanation for this might be that short-haul pilots and long-haul pilots had almost the same level of occupational cancer awareness.

These findings suggest that pilots should be informed on occupational cancer, risk factors, and preventive actions through recurrent trainings and e-learnings. The flight training departments of airlines should pay special attention to this particular issue in order to increase awareness of pilots on occupational cancer. Targeted educational efforts should be implemented to increase awareness among airline pilots. Pilots should be encouraged to wear sunscreen in the flight deck. Pilot unions, airline pilots' associations and airline companies should call for more educational efforts. Flight schools and flight training departments of universities should inform their students (ab-initio pilots) about occupational cancer, risk factors, and preventive actions. Civil aviation authorities may publish informative documents for aviators.

As mentioned in the introductory section of this paper, high cancer awareness may contribute to early diagnosis and improve cancer survival. Therefore, it is highly important that organizations (e.g., airlines, civil aviation authorities, flight training organizations, and pilot training departments of universities) should provide adequate supervision.

4. Conclusion

This study set out with the aim of examining the awareness levels of airline pilots on occupational cancer. To the best of our knowledge, no research has been conducted so far to investigate the awareness level of airline pilots on occupational cancer. The findings from this study made several contributions to the current literature. First, it has demonstrated, for the first time, that the level of awareness on occupational cancer among airline pilots was low. Second, the need for supervisory support (e.g., recurrent trainings, e-learnings, webinar, and seminar) has increased.

The most important limitation is that a cross sectional design was used in this study. A further study could assess the cancer incidence among airline pilots to determine whether workplace factors play a role. Another limitation of our study was the language of the survey. Although the English proficiency of airline pilots is at good level, the survey should have been applied in Turkish language to overcome language-related misconceptions and misunderstandings. In summary, these results indicated that implications (e.g., cancer awareness programs such as pink chain campaigns and training programs) to inculcate healthy lifestyle among pilots and to increase their level of knowledge about occupational cancer may help to create awareness about occupational cancer among airline pilots, reduce cancer risks, and enhance overall safety in aviation.

Appendix

1. Gender
   a. Female
   b. Male
2. Which of the following categories describes your age?
   a. 20-30
   b. 31-40
   c. 41-50
   d. 51-60
   e. 61 and older
3. Which position do you hold?
   a. Second officer
   b. First Officer
   c. Senior First Officer
   d. Commander
4. How long have you been flying?
   a. Less than 5 years
   b. 5 to 10 years
   c. 11 to 15 years
   d. 16 to 20 years
   e. More than 20 years
5. What type of aircraft do you fly?
   a. Short-haul (Airbus A320, Boeing 737 etc.)
   b. Long-haul (Airbus A330, A380, A350, Boeing 777,787, 747 etc.)
6. How many hours do you usually fly in a month?
   a. Up to 60 hours
   b. 61-70 hours
   c. 71-80 hours
   d. 81-90 hours
   e. More than 90 hours
7. I read books, academic articles and magazines on aviation-related cancer and follow social media for this issue?
8. I have been informed about aviation-related cancer by e-learnings and recurrent trainings
9. My knowledge of the cosmic radiation contributing to cancer is...
10. My knowledge of the UV radiation contributing to cancer is...
11. My knowledge of the circadian rhythm disruption/ shift work contributing to cancer is...
12. My knowledge of the exhaust gases from the engine contributing to cancer is...
13. My knowledge of the electromagnetic fields (from cockpit instruments) contributing to cancer is...
14. My knowledge of the inadequate diet contributing to cancer is...
15. My knowledge of the job stress/psychological demand contributing to cancer is...

16. My knowledge of that airline pilots are occupationally exposed to higher level of UV radiation and cosmic radiation
17. Do you smoke or have you ever smoked cigarettes?
    a. Yes
    b. No
18. I wear sunscreen in the flight deck
19. I can maintain a balanced diet during the flight and layover. Balanced Diet: a) Protein in fish, meat, poultry, dairy products, eggs, nuts. b) Fat found in animal and dairy products. c) Carbohydrates found in fruits, vegetables, whole grains, and beans. d) Vitamins. e) Minerals and f) water.
20. I am aware of the recreational sun exposure (during the holidays and layovers) which accounts for a large number of acute and chronic dermatological diseases, including skin cancer

Ethical approval

The study protocol received ethical approval from the Özyeğin University's Human Research Ethics Board (2020/12/02).

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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References

Ahsan MA, Munir UR, Ahmad M, & Shahidullah M. (2016). Effects of Smoking on Pilots of Bangladesh Air Force in Dhaka Area. Journal of Armed Forces Medical College Bangladesh, 12(1), 22–27.

Alberg, A. J., & Samet, J. M. (2003). Epidemiology of lung cancer. Chest, 123, 21–49.

Armstrong, B., & Doll, R. (1975). Environmental factors and cancer incidence and mortality in different countries, with special reference to dietary practices. International Journal of Cancer, 15(4), 617–631.

Bagshaw, M., & Cucinotta, F. A. (2008). Cosmic Radiation. In Fundamentals of Aerospace Medicine (4th ed., pp. 221–235). Lippincott Williams & Wilkins.

Bagshaw, M., & Illig, P. (2018). The aircraft cabin environment. In Travel Medicine (Fourth Edi, pp. 429–436). Elsevier Inc. https://doi.org/10.1016/B978-0-323-54696-6.00047-1

Cadilhac, P., Bouton, M. C., Cantegril, M., Cardines, C., Gisquet, A., Kaufman, N., & Klerlein, M. (2017). In-flight ultraviolet radiation on commercial airplanes. Aerospace Medicine and Human Performance, 88(10), 947–951.

Carbone, D. (1992). Smoking and Cancer. The American Journal of Medicine, 93(1), S13–S17.

Dyro, J. F., & Morris, R. L. (2004). Medical Device Troubleshooting. In Clinical Engineering Handbook (pp. 436–447). Elsevier Inc.

Gander, P. H., Mulrine, H. M., van den Berg, M. J., Smith, A. A. T., Signal, T. L., Wu, L. J., & Belenky, G. (2014). Pilot fatigue: Relationships with departure and arrival times, flight duration, and direction. Aviation Space and Environmental Medicine, 85(8), 833–840.

Garabrant, D. H., Peters, J. M., Mack, T. M., & Bernstein, L. (1984). Job Activity and Colon Cancer Risk. American Journal Op Epidemiology, 119(6), 1005–1014.

Goffeng, E. M., Wagstaff, A., Nordby, K. C., Meland, A., Goffeng, L. O., Skare, Ø., Lilja, D., & Lie, J. A. S. (2019). Risk of fatigue among airline crew during 4 consecutive days of flight duty. Aerospace Medicine and Human Performance, 90(5), 466–474.

Gudmundsdottir, E. M., Hrafnkelsson, J., & Rafnsson, V. (2017). Incidence of cancer among licenced commercial pilots flying North Atlantic routes. Environmental Health: A Global Access Science Source, 16(1).

Haldorsen, T., Reitan, J. B., & Tveten, U. (2000). Cancer incidence among Norwegian airline pilots. Scandinavian Journal of Work, Environment & Health, 26(2), 106–111.

Hall, M. T., Austin, R. P., Do, T. A., & McGlynn, A. (2018). Vape and Aviate: Electronic-Cigarette Use and Misuse in Naval Aviation. Military Medicine, 183(3–4), E165–E170.

Hammer, G. P., Auvinen, A., de Stavola, B. L., Grajewski, B., Gundestrup, M., Haldorsen, T., Hammar, N., Lagorio, S., Linnersjö, A., Pinkerton, L., Pukkala, E., Rafnsson, V., Dos-Santos-Silva, I., Storm, H. H., Strand, T. E., Tzonou, A., Zeeb, H., & Blettner, M. (2014). Mortality from cancer and other causes in commercial airline crews: A joint analysis of cohorts from 10 countries. Occupational and Environmental Medicine, 71(5), 313–322.

Hammer, G. P., Blettner, M., Langner, I., & Zeeb, H. (2012). Cosmic radiation and mortality from cancer among male German airline pilots: Extended cohort follow-up. European Journal of Epidemiology, 27(6), 419–429.

Herr, H. W. (2011). Percivall Pott, the environment and cancer. BJU International, 108(4), 479–481.

ICAO. (2012). Manual of Civil Aviation Medicine-Doc 8984.

Irvine, D., & Davies, D. M. (1999). British Airways flightdeck mortality study, 1950-1992. Aviat Space Environ Med, 70(6), 548–555.

Kaji, M., Tango, T., Asukata, I., Tajima, N., Yamamoto, K., Yamamoto, Y., & Hokari, M. (1993). Mortality experience of cockpit crewmembers from Japan Airlines. Aviation, Space, and Environmental Medicine, 64(8), 748–750.

Key, T. J., Bradbury, K. E., Perez-Cornago, A., Sinha, R., Tsilidis, K. K., & Tsugane, S. (2020). Diet, nutrition, and cancer risk: What do we know and what is the way forward? The BMJ, 368(March), 1–9.

Kilic, B. (2021). Self-Medication Among Ab Initio Pilots. Aerospace Medicine and Human Performance, 92(13), 1–6.

Kilic, B., & Soran, S. (2020). Awareness level of airline pilots on flight-associated venous thromboembolism. Aerospace Medicine and Human Performance, 91(4), 1–5.

Langner, I., Blettner, M., Gundestrup, M., Storm, H., Aspholm, R., Auvinen, A., Pukkala, E., Hammer, G. P., Zeeb, H., Hrafnkelsson, J., Rafnsson, V., Tulinius, H., De Angelis, G., Verdecchia, A., Haldorsen, T., Tveten, U., Eliasch, H., Hammar, N., & Linnersjö, A. (2004). Cosmic radiation and cancer mortality among airline

pilots: Results from a European cohort study (ESCAPE). Radiation and Environmental Biophysics, 42(4), 247–256.

Lindgren, T., Wieslander, G., Dammstrom, B. G., & Norback, D. (2008). Hearing status among commercial pilots in a Swedish Airline Company. International Journal of Audiology, 47(8), 515–519.

McCartney, M. A., Chatterjee, B. F., McCoy, E. C., Mortimer, E. A., & Rosenkranz, H. S. (1986). Airplane emissions: A source of mutagenic nitrated polycyclic aromatic hydrocarbons. Mutation Research, 171(2–3), 99–104.

Newman, W. G., Agro, A. D., Woodruff, S. I., & Mayer, J. A. (1996). A Survey of Recreational Sun Exposure of Residents of San Diego, California. American Journal of Preventive Medicine, 12(3), 186–194.

Nicholas, J. S., Lackland, D. T., Butler, G. C., Mohr, L. C., Dunbar, J. B., Kaune, W. T., Grosche, B., & Hoel, D. G. (1998). Cosmic radiation and magnetic field exposure to airline flight crews. American Journal of Industrial Medicine, 34(6), 574–580.

Oliveria, S. A., Saraiya, M., Geller, A. C., Heneghan, M. K., & Jorgensen, C. (2006). Sun exposure and risk of melanoma. Archives of Disease in Childhood, 91(2), 131–138.

Rachelle Harry. (2019). Cargolux Airlines joins fight against cancer with Fly Pink initiative. https://www.aircargonews.net/off-the-record/cargolux-airlines-joins-fight-against-cancer-with-fly-pink-initiative/

Ramazzini, B. (2001). De morbis artificum diatriba [Diseases of workers]. American Journal of Public Health, 91(9), 1380–1382.

Raslau, D., Dabrh, A. M. A., Summerfield, D. T., Wang, Z., Steinkraus, L. W., & Murad, M. H. (2016). Prostate cancer in pilots. Aerospace Medicine and Human Performance, 87(6), 565–570.

Ritchie, G. D., Still, K. R., Rossi, J., Bekkedal, M. Y. V., Bobb, A. J., & Arfsten, D. P. (2003). Biological and health effects of exposure to kerosene-based jet fuels and performance additives. Journal of Toxicology and Environmental Health - Part B: Critical Reviews, 6(4), 357–451.

Rodriguez, H. A. F., & Ortiz Mayorga, V. A. (2016). Characterization of low back pain in pilots and maintenance technicians on a commercial airline. Aerospace Medicine and Human Performance, 87(9), 795–799.

Şen, S., Barlas, G., Yakıştıran, S., Derin, İ. G., Şerifi, B. A., Özlü, A., Braeckman, L., van der Laan, G., & van Dijk, F. (2019). Prevention of Occupational Diseases in Turkey: Deriving Lessons From Journey of Surveillance. Safety and Health at Work, 10(4), 420–427.

Siemiatycki, J., Gerin, M., Steward, P., Nadon, L., Dewar, R., & Richardson, L. (1988). Associations between several sites of cancer and ten types of exhaust and combustion products. Results from a case-referent study in Montreal. Scandinavian Journal of Work, Environment and Health, 14(2), 79–90.

Staff Writer. (2021). How you can support breast cancer research fundraising. https://news.delta.com/how-you-can-support-breast-cancer-research-fundraising

Stevens, R. G., Davis, S., Thomas, D. B., Anderson, L. E., & Wilson, B. W. (1992). Electric power, pineal function, and the risk of breast cancer. The FASEB Journal, 6(3), 853–860.

United States Department of Labor. (2021). Non-Ionizing Radiation. Safety and Health Topics. https://www.osha.gov/non-ionizing-radiation

Van Tongeren, M., Jimenez, A. S., Hutchings, S. J., MacCalman, L., Rushton, L., & Cherrie, J. W. (2012). Occupational cancer in Britain: Exposure assessment methodology. British Journal of Cancer, 107, S18–S26.

Wang, S. W., Tai, H. C., Tang, C. H., Lin, L. W., Lin, T. H., Chang, A. C., Chen, P. C., Chen, Y. H., Wang, P. C., Lai, Y. W., & Chen, S. S. (2020). Melatonin impedes prostate cancer metastasis by suppressing MMP-13 expression. Journal of Cellular Physiology, August, 1–12.

WHO-International Agency for Research on Cancer. (2010). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 98. http://publications.lib.chalmers.se/records/fulltext/245180/245180.pdf/0Ahttps://hdl.handle.net/20.500.12380/245180/0A

Wollschläger, D., Hammer, G. P., Schafft, T., Dreger, S., Blettner, M., & Zeeb, H. (2018). Estimated radiation exposure of German commercial airline cabin crew in the years 1960-2003 modeled using dose registry data for 2004-2015. Journal of Exposure Science and Environmental Epidemiology, 28(3), 275–280.

Yong, S. S., Han, W. H., Faheem, N. A. A., Puvan, N., Tan, L. L., Wong, S., & Kwan, Z. (2022). Predictive factors of sun protection behaviour among global airline pilots. Photodermatology, Photoimmunology & Photomedicine.

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