Frequently Asked Questions: A Study of Breast Cancer in Female Flight Attendants

June 2017

General

Q: Who conducted the study?

A: The study was led by researchers from the National Institute for Occupational Safety and Health (NIOSH) and conducted in collaboration with researchers at the National Cancer Institute (NCI). NIOSH is a government research agency that works to improve the safety and health of America's workers. It is a part of the Centers for Disease Control and Prevention (CDC). Funding was provided by NIOSH, NCI, and the US Department of Health and Human Services Office of Women's Health.

Q: Why was the study done?

A: The study was done to better understand the potential link between working as a flight attendant and breast cancer. Flight attendants are exposed to cosmic radiation, which increases with altitude and latitude, and circadian disruption (jet lag). Other forms of ionizing radiation are known to cause cancer, and the International Agency for Research on Cancer (IARC) has determined that circadian disruption probably causes cancer. In addition, some known risk factors for breast cancer such as parity (the number of times a woman has given birth) and age at first birth are more frequent in flight attendants.

Q: Why did you study women who had worked as a flight attendant at Pan Am?

A: Several years after Pan Am went out of business, they contacted us to see if we would like to obtain any of the employee records. They were required to do this by law. We decided to obtain these records so that we could conduct studies of aircrew. We started three studies among aircrew: a study of deaths among cockpit crew, a study of deaths among flight attendants, and a study of diagnoses of breast cancer and other cancers among female flight attendants. A summary of the findings from the study of deaths among flight attendants is available at www.cdc.gov/niosh/pgms/worknotify/. The purpose of this information is to let you know about the findings from the study of diagnoses of breast cancer.

Q: What other health studies has NIOSH done in aircrew?

A: NIOSH scientists have also evaluated reproductive health (miscarriages and endometriosis), respiratory health (work-related eye, nose, and throat symptoms, wheezing, asthma, chest illness, and cold or flu), sleep disturbance, and job stress in flight attendants as well as chromosome translocations in pilots. NIOSH scientists have also collaborated with other scientists to evaluate mortality in aircrew from ten countries. The evaluation of other cancers (in addition to breast cancer)and other reproductive health outcomes in flight attendants is on-going. Please visit the NIOSH Aircrew Safety & Health webpage at www.cdc.gov/niosh/topics/aircrew for more information.

Q: What is the purpose of the NIOSH studies of health in aircrew?

A: In general, the purpose of all of our studies is to learn if the work-related exposures are linked to health problems. If a link is found, the goal is for steps to be taken to protect the health of workers.

Q: How will the results of these studies be used to improve working conditions for aircrew?
A: Regulatory agencies, organizations, and airline companies use the results of research studies to develop regulations, guidelines, and policies to protect the health of workers. If the results of our studies and other studies reveal a clear link between work-related exposures and adverse health of aircrew, such actions may be taken for aircrew.

Q: Why did this study take so long?
A: These types of studies typically take a number of years because of the time needed to locate and survey eligible workers; obtain medical records and cancer registry data; code all data; estimate exposure for each worker, and analyze the data. After we analyzed, interpreted, and wrote up the findings, the papers also underwent a rigorous review to verify that results are sound. This all had to occur before the results could be published and released.

Q: What units did you use when you estimated exposure to cosmic radiation?
A: In our study, we used milligrays (mGy). This is a unit used to measure absorbed dose. Absorbed dose is the amount of cosmic radiation absorbed by a person. To compare estimates of exposure to international and national guidelines, we also provided estimates in millisieverts (mSv). This is a unit for effective dose. Effective dose is the amount of radiation absorbed by a person, taking into account the types of radiation and the effect on different organs in the body.

Study Methods

Q: How was the study done?
A: Our study had 5 steps:

Step 1. We identified women who were eligible for the study from Pan Am company records.
Women who were eligible for the study

- Were US citizens,
- Worked for at least one year as a flight attendant at Pan Am and National Airlines, and
- Lived in the United States.

Step 2. We invited these women to complete a survey.
If a woman was deceased or unable to complete the survey, we invited a family member to complete the survey. In the survey, we asked about cancer diagnoses, risk factors for breast cancer, and flights flown while working. The questionnaire also asked for permission to obtain information from medical records about any cancers that were reported.

Step 3. We identified breast cancer cases.
We identified breast cancer cases from the surveys, medical records, and linkage to cancer registries in six states (CA, FL, NY, TX, VA, and WA). We also searched the causes of death listed on death certificates.

Step 4. We assessed each woman's exposure to cosmic radiation and circadian disruption.
We assessed two measures of circadian disruption – time zones crossed and time spent working during normal sleep hours.

Because records of the flights each woman worked on did not exist, we estimated each woman's exposure to cosmic radiation and circadian disruption based on her work history (that is, assigned home base domiciles, time period employed at each domicile, block hours per month, and number of commuter flights flown per month). We did this by first estimating the average cosmic radiation dose, number of time zones crossed,

and hours spent working during normal sleep hours incurred by a flight attendant, by domicile and time period, using historical flight schedule data. Cosmic radiation dose for each flight in the flight schedules was calculated using the Federal Aviation Administration (FAA) software program CARI6P, which calculates the dose for an individual flight segment. We then linked these estimated averages with the work history data to estimate each woman's cumulative exposure to cosmic radiation, number of time zones, and hours spent working during their normal sleep hours.

The estimates for each woman in the study took into account differences in flights between domiciles and over time as well as differences in average block hours worked and commuter segments flown, but did not account for differences in flights between flight attendants based at the same domicile at the same time.

Step 5. We compared breast cancer diagnoses by various groups.

To examine the potential link of breast cancer with job exposures, we compared breast cancer diagnoses in the following groups:

- Women in the study compared with women in the US general public
- Women in the study who worked for more years as a flight attendant compared with those who worked fewer years
- Women with more exposure to cosmic radiation compared with women with less exposure
- Women who crossed more time zones compared with women who crossed fewer time zones.
- Women who worked more hours during normal sleep hours compared with women who worked fewer hours during normal sleep hours.

When we compared breast cancer diagnoses in the first group above, we assessed the likely impact of differences in parity and age at first birth among women in the study compared with women in the general population. When we compared breast cancer diagnoses in the other groups, we took into account differences in parity, age at which they first gave birth, and other known risk factors for breast cancer.

Q: What were the limitations of the study?

A: Our study had many limitations:

- We did not have records of the individual flights that each flight attendant worked on so we could not account for differences in exposure to cosmic radiation and circadian disruption between flight attendants based at the same domicile at the same time.
- We also could not account from exposure to cosmic radiation from solar particle events. These events are rare, though. In a separate study, pilots flew through about 6 solar particle events in an average 28-year career.
- Because exposure to cosmic radiation and circadian disruption were closely linked, we could not separate these exposures.
- The average duration of employment as a flight attendant was rather short, and the average cumulative exposure to cosmic radiation was rather low, which may have affected our ability to detect a link between cosmic radiation and breast cancer (if one exists).
- Many women who were eligible for the study did not participate, and this may have affected the results.
- Women who had been diagnosed with breast cancer may have been more likely to recall some of the things we asked about in the survey than women who weren't diagnosed with breast cancer.

Q: Why did you study deaths before you studied cancer diagnoses among former Pan Am flight attendants?

A: Studies of workers in the United States commonly look at deaths because this can be done using existing records. In these studies, deaths are identified by linking a list of workers with national death data. We also needed to identify former Pan Am flight attendants who had died before we could study cancer diagnoses.

Q: Did you obtain input from flight attendants when you designed the study?

A: Yes, we obtained input from several former Pan Am flight attendants when we were designing the study. NIOSH researchers also obtained input from aircrew, unions, airline companies, and unions representing aircrew for other health studies of aircrew.

Q: Many Pan Am flight attendants were not US citizens. Why didn't you include them in your studies?

A: The main reason we didn't include them in our studies was because they may have been more likely to be living outside of the United States when they died. Yet, we needed to find out if each person in the study had died and if so, from what causes. We don't have good and reliable ways to do this for people who moved outside of the United States.

Q: How far back did the study go?

A: The study includes women who last worked for Pan Am in 1953 or later. Women who last worked for Pan Am before this weren't included because the records we obtained from Pan Am weren't complete prior to 1953.

Q: Why didn't you include pilots or other cockpit crew in the study?

A: We assessed deaths among former Pan Am cockpit crew in a separate study. We did not include cockpit crew in the study of cancer diagnoses because the main purpose of this study was to assess breast cancer in women, and most former Pan Am cockpit crew were men. For more informatin see:

Yong, L, Pinkerton, L, Yiin, J, Anderson, J, Deddens, J (2014). Mortality among a cohort of U.S. commercial airline cockpit crew. Am. J. Ind. Med; 57(8):906-914

Q: I know several women were diagnosed with breast cancer after completing your survey. Wouldn't this affect the validity of your study?

A: No, the study is still valid even though it missed breast cancers that were diagnosed after the surveys were completed. When we analyzed the data, we took into account how long each woman lived before completing the survey, being diagnosed with breast cancer, or dying.

Q: Why did you compare flight attendants with the general population?

A: We did this to see if flight attendants had higher rates of deaths or higher rates of breast cancer than the general public of the United States. Studies of workers often find that workers are healthier than the general population; this "healthy worker effect" is due to factors such as access to health insurance, screening physicals for incoming employees, and people who are too ill to work not entering the workforce. This effect tends to be stronger for non-cancer outcomes than for cancers.

Q: When you compared women in the study with women in the general population, couldn't the findings be due to differences in the ages of women in the study compared with women in the general population?

A: No. When we compared women in the study with women in the general population, we took into account differences in age, race, and birth year.

Q: Why did you include women who only worked as a flight attendant for one year or so in the breast cancer study?

A: We included women who only worked for a year so that we could compare breast cancer diagnoses in women who worked for many years and had more cumulative exposure to cosmic radiation and circadian disruption with women who didn't work as long and had less exposure. This allowed us to assess the link of breast cancer with exposure to cosmic radiation and circadian disruption.

Q: What known and suspected risk factors for breast cancer did you consider in your study?
A: We considered many factors including age, race/ethnicity, birthplace, education, family history of breast cancer, body mass index, smoking, alcohol use, parity, age at first birth, breastfeeding, age when menstrual periods started, age at menopause, hormone replacement therapy, history of having a breast biopsy, and history of radiation to the chest area from radiation treatment or diagnostic exams. For information on known risk factors for breast cancer, visit www.cdc.gov/cancer/breast/basic_info/risk_factors.htm.

Q: Exposure to cosmic radiation is higher on flights that flew at higher altitudes and polar routes. Did you take this into account when you estimated exposure to cosmic radiation?
A: Yes, we took these into account.

Other exposures and health outcomes of concern

Q: Have you assessed lung cancer or other respiratory diseases among flight attendants?
A: We assessed deaths from lung cancer and other respiratory diseases in the previous study of deaths among former Pan Am flight attendants. Deaths from lung cancer were less frequent than we would have expected based on statistics from the general population. We observed 65 deaths from lung cancer. We expected 116. Deaths from respiratory diseases other than cancer, including chronic obstructive pulmonary disease (COPD), were also less frequent than we would have expected. We observed 51 deaths from other respiratory diseases; we expected 98.

There are limitations to this assessment.

- The findings do not take into account differences in smoking between flight attendants in the study compared with the general population.

- We were not able to assess the link between deaths from lung cancer and other respiratory diseases with exposure to second-hand smoke in the aircraft cabin because smoking was allowed on most flights when Pan Am was in operation, and we do not have a good way to group former Pan Am flight attendants according to the amount of their exposure to second-hand smoke in the aircraft cabin.

Q: Why aren't you assessing the link between second-hand smoke and diagnoses of lung cancer in women who worked as flight attendants at Pan Am?
A: We wanted to do this when we started planning the study. But, after talking with former flight attendants and others, we could not identify a good way to assess exposure to second-hand smoke. Even if we had, the findings may not have provided much insight into the link with second-hand smoke in flight attendants because of the small number of lung cancers in women who completed our survey and the need to take smoking into account.

Q: Are you assessing the impact of exposure to pesticides from working as a flight attendant on health?
A: No, we aren't doing this because we do not have a good way to estimate exposure to specific pesticides among women in the study.

Q: Are you assessing the impact of working as a flight attendant on reproductive health?
A: Other NIOSH researchers are conducting separate studies looking at the impact of working as a flight attendant on reproductive health. Visit www.cdc.gov/niosh/topics/aircrew/reproductivehealth to learn more.

Study findings and what they mean

Q: What domiciles were women in the study based at?

A: The women in the study worked for many airlines in addition to Pan Am and were based at many different domiciles. The most common domiciles for all airlines were New York, Miami, San Francisco, Los Angeles, Honolulu, and Washington, DC.

Q: In the previous study, flight attendants were not more likely to die from breast cancer than the US general population. In this study, they are more likely to be diagnosed with breast cancer. Were women in the study more likely to get breast cancer or not?

A: Yes, women in the study were more likely to get breast cancer. But, they were not more likely to die from breast cancer. This suggests that women in the study were more likely to survive breast cancer than other women, perhaps because of better access to medical care.

Q: I'm healthy right now. Does this mean I'll get breast cancer?

A: We don't know, simply from this study, whether or not you will get breast cancer. Instead, our study found that female flight attendants, on average, are more likely to get breast cancer compared to the general population.

Q: Should I undergo breast cancer screening tests?

A: All women who worked as a flight attendant should talk with their health care provider about breast cancer screening tests.

Q: What are the risk factors for breast cancer?

A: Please visit www.cdc.gov/cancer/breast/basic_info/risk_factors.htm for information on risk factors for breast cancer.

Q: How much cosmic radiation were women in the study exposed to while working as flight attendants?

A: We estimated that women in the study were exposed to up to 17 mSv/year of cosmic radiation from their work as a flight attendant, with an average of 2.5 mSv/year. For comparison, the radiation dose from a CT scan of the chest is about 7 mSv; the dose from a chest x-ray is about 0.02 mSv.

Q: What are the recommended exposure limits for cosmic radiation exposure?

A: There are no official exposure limits for aircrew in the United States, but there are international guidelines.

The International Commission on Radiological Protection (ICRP) considers aircrew to be exposed to cosmic radiation on their jobs. They recommend limits of 20 mSv/year averaged over 5 years (that is, a total of 100 mSv in 5 years) for radiation workers. For pregnant radiation workers, the ICRP recommends a limit of 1 mSv throughout pregnancy.