

# A literature study on the analysis of physical risks on employees of the aviation industry

## Abstract

The aviation industry, which is highly technologically advanced, provides great employment opportunities for countries, and is of economic and socio-cultural importance, continues to develop. With this development comes new risks. States and companies evaluate, analyze and control these risks with various management approaches. Risks are elements that contain uncertainty about harm and danger. It is not possible to completely eliminate risks. However, its effects can be minimized. This requires risk management. The cost of the work done to prevent risks is quite low compared to the cost that will occur after the risk occurs. In this study, a literature study was conducted on the physical risks that the employees in the aviation industry are exposed to and the occupational diseases they cause.

**Keywords:** aviation human resources, physical risks, airline transportation, risk management, flight crews, ground handling services

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## Introduction

Air transport is a large and subdivided industry. Jobs can be divided into two main groups. Flight crews and ground handling workers. Many employees are exposed to various risks and hazards in the workplace. This study provides an overview of the physical risks in the airline transport industry, including flight crew and ground crew. The main purpose of this study is to draw attention to the physical risks that air transport workers are exposed to, thus contributing to the studies on these risks in the management understanding of companies. Potential risks are defined by their cause and consequences. In this study, the physical risks that aviation sector employees are exposed to were examined by literature research. Many different databases are used while performing the literature review. With the opportunities offered by today's technology, many resources are transferred to the internet environment. In this study, a predominantly internet-based study was conducted. Legal obligations and preventive measures will not be discussed.

## Physical dangers

One of the risk and danger factors in the aviation industry is physical work factors. Risks and hazards such as noise, vibration, temperature and pressure are the main physical working factors for the aviation industry. The main physical hazards that particularly affect airside ground personnel are exposure to noise and vibration. The main sources of noise and vibration from airport operations are aircraft during landing and take-off, followed by ground operations equipment and vehicles.<sup>1</sup>

When we look at the ambient air; Extremely dry cabin air is another physical hazard to flight crew. The relative humidity of the aircraft, low humidity in the air during flight can cause dry skin and dry mucous membranes in the eyes and nose, which can lead to dry respiratory infections.<sup>2</sup>

Physical hazards are the hazards arising from the factors specific to the conditions in the working areas. There may be significant differences in the risk ratios of unchanging hazards, as the hazards vary according to the sector and even the different working areas within the sector. We see that the working areas in the aviation sector are generally divided into flight lines and ground services. There are

many occupational accidents in both areas. Physical hazards lie in the main cause of most of the occupational accidents encountered at work sites. It will be examined under the following headings: Noise, Vibration, Cosmic Radiation, Ergonomic Factors

## Noise

The main physical hazards affecting ground crew are exposure to noise and vibrations. The main sources of noise and vibration arising from airport operations are the airport works carried out during the landing and take-off of the aircraft, and then the equipment and vehicles used in ground operations. Noise from aircraft engines, auxiliary power units (APU), ground vehicles and equipment on the ramp can exceed 85 decibels (dB). Exposure to noise can cause permanent hearing loss in chronic exposures equal to an average sound pressure level of 85 dB(A) or higher over an eight-hour period.<sup>3</sup> Noise is known to impair hearing health as well as mental functions and psychology; Here, subjective evaluation of sounds and personal perception differences (relativity) are also in question (perceived noise level). Sounds of 80-90 dB and above harm the ears physically and physiologically. There is a consensus that noise causes fear, stress, memory and perception defects, narrowing of attention, forgetfulness, focusing disorder, insomnia, fatigue, aggression, irritability, psychomotor skill decrease, communication deterioration, error increase, and ultimately contributes to accidents. It has been proven to cause problems such as focusing disorder, decreased visual attention, difficulty in parsing auditory information and increased error in nursery children and teachers near the railway. The negative effects of noise on functions such as reading comprehension, language learning, response time, problem solving and math skills are common results of many studies. In aviation, the communication of the crew with each other in the cockpit, with other aircraft and with ground centers may be severely impaired due to noise; There may even be accidents due to no understanding or misunderstanding due to external sounds masking speech or signals.<sup>4</sup>

Acute acoustic trauma Hearing loss due to high-intensity sound trauma, acoustic traumas caused by cannon and firearms are examples of these. Chronic sound trauma of the inner ear; It is hearing loss that occurs as a result of long exposure to a certain loud sound. Hearing loss that occurs for a long time in people working in noisy places is an example of this type. It is a well-known fact that permanent

changes in hearing threshold occur when exposed to high-intensity noise continuously for 15 years in daily life.<sup>5</sup>

Flight crew are also exposed to noise and vibrations from moving aircraft. Whole body vibrations occur during flight, especially during landing and takeoff or turbulence. Poor sitting with improper shock absorption increases the risk of musculoskeletal disorders. Working long hours in a pressurized cabin can cause in-flight barotrauma. Barotrauma is induced by pressure changes during ascent and descent in aviation, most commonly affecting the middle ear. It occurs when the Eustachian tube is blocked and therefore cannot equalize the air pressure in the middle ear with the external cabin pressure. Barotrauma can be painful and seriously affect the concentration and working capacity of the flight crew.<sup>6</sup>

Along with the weakening of hearing ability over time, employees may experience behavioral disorders in their daily lives. Many ailments can be detected, especially as a result of periodic checks made to flight crews. As a result of these diagnoses, a temporary or permanent airworthiness report is issued.

### Vibration

Driving vehicles (including forklifts) or working with ground operations equipment creates a risk of whole-body vibrations for workers. Whole body vibrations are mechanical vibrations transmitted to the body from the back or the foot in the case of sitting work, standing work. Exposure to high-frequency whole-body vibrations over the years can cause balance disorders, visual disturbances, stomach problems, reduced fine motor skills, or affect the spine. Hand-arm vibrations can cause circulatory disorders in the fingers (eg, white finger disease (or hand-arm vibration syndrome), degenerative changes (vibration) in the hand bones, finger joints and wrists, elbow and shoulder regions.<sup>7</sup>

The main sources of vibration, which is one of the inevitable stressors of aviation, are propeller and engine. Especially in helicopters, vibration is high and it is one of the main causes of low back pain and joint stiffness. As the vibration increases, nausea, dizziness, tinnitus, skin burning, increased salivation, sweating and a feeling of choking-choking in the chest occur; thermoregulation of the body is disturbed. Even with coarse vibration, there is an increase in difficulty and error in instrument reading, display monitoring, motor activity and command. The internal vibration of each part of the body that resonates with the external vibration from the aircraft creates serious disturbances. The resonance of the eyeballs at the level of 30-40 Hz makes visual focusing impossible, blurred vision occurs. At 60 Hz, resonance occurs in the head, limbs, chest, abdominal wall and body cavities. In these conditions, cognitive and psychomotor performance is impaired; speech, hearing and communication also become difficult. Some people experience discoloration and pain due to spasm of the finger veins.<sup>8</sup>

Working long hours in a pressurized cabin can cause in-flight barotrauma. Barotrauma begins with pressure changes during ascent and descent in aviation, most commonly affecting the middle ear. It occurs when the Eustachian tube is blocked so that it cannot equalize the air pressure in the middle ear with the external cabin pressure. Barotrauma can be painful, severely affecting the concentration and working capacity of the flight crew. Air pressure in an airplane is like on the top of a mountain 2.4 km high. Air is pumped to keep the cabin at 10 degrees Celsius, while the humidity is as high as in the driest parts of the world. Due to the low air pressure, the oxygen rate in the blood decreases by 6-25 percent. Decreased oxygen in the blood is called hypoxia. In such a case, oxygen supplementation is

given in the hospital. In healthy people, this does not cause many problems, but it negatively affects the elderly and those with breathing problems. Decreased oxygen affects people's ability to think clearly. As the oxygen level drops further at 3.6 km altitude, even in healthy individuals, memory, calculation and decision-making abilities are negatively affected. For this reason, it is mandatory for pilots to wear an oxygen mask at an altitude of 3.8 km. In flights at an altitude of 2.4 km, there may be a change in perception and reflex due to the oxygen level. But this doesn't affect healthy people, according to Hinkelbein. But perceptual weakening is more pronounced in people who already have a problem due to the flu or any other reason. Mild hypoxia in flight also has other, more pronounced effects on the brain. Lack of oxygen makes people tired.<sup>9</sup>

Hypertension is a common medical problem both among individuals traveling by air and among flight crew members. Changes in cabin/cockpit interior conditions due to high altitude may cause blood pressure to rise.

### Cosmic Radiation

Cosmic radiation comes from outside the solar system and consists of extremely energetic particles. Most cosmic radiation is absorbed by the atmosphere. However, cosmic radiation doses increase with altitude. Flying at higher altitudes, common in long-haul flights, can expose the flight crew to high levels of cosmic radiation. Flight crews are one of the most exposed professional groups, with an average annual exposure of 2.4 milliseverts in 2009. According to the German radiation protection monitoring program, the annual average radiation dose, the average effective dose below 1.0 millisecond, is even higher than that of medical personnel working in radiology.<sup>10</sup>

How much is the dose of cosmic radiation on airplanes? Dose size:

- Flight altitude
- Flight time
- To the reactions (activity) in the sun

It changes depending on the geographical (geomagnetic) latitude of the flight path followed. Earth's magnetic field deflects electrically charged cosmic particles (radiation) before they even enter the atmosphere. This deviation is most active in the Equatorial Region. Up to 30 degrees north and south latitudes, magnetic field lines run approximately parallel to the earth's surface, and only a fraction of the cosmic radiation in excess energy can enter the atmosphere. Since the geomagnetic poles are 1600 km outside of the world's geographic poles, the atmosphere between the Earth's 60 degrees latitude and the poles cannot be protected, the effect of cosmic radiation is greatest in these regions and reaches its highest value, which is 2-3 times that of the equator at 60° north latitude. In the hemisphere, it is 2-3 times less than in the north. Although it is very rare, radiation physicists argue that a flight ban should be imposed even at such times, since the radiation dose increases when the activities in the sun reach extreme values. For example, in 1957, when solar activity was very extreme, at an altitude of 12,000 m, a very extreme value of 10 mSv per hour was measured, and in 1989 0.1 mSv per hour was measured.<sup>11</sup>

The American Civil Aviation Authority (FAA) reports that pilots and cabin crew are exposed to more radiation each year than workers at nuclear power plants. Again, in a scientific determination; The body of a person traveling at an altitude of 11 thousand meters for 4 hours collects as much radiation as an X-ray film. Certain types of cancer are more common among aircraft personnel who have been exposed to the harmful effects of their profession for many years. According

to flight regulations, it is considered undesirable for a pilot to fly more than 110 hours per month. In pilots and cabin crews working for many years under the influence of cosmic radiation intensified by solar flares; The risk of cancers such as bone, testis, brain, bladder, breast and colon increases. The harmful effect of the rays intensifies, especially when you go to an altitude above 10 thousand meters.<sup>12</sup>

The biggest reason why the aviation industry is one of the riskiest business groups is cosmic radiation. Especially in transoceanic flights, flight crews are exposed to serious amounts of radiation. Most employees do not have enough awareness about these radiation amounts. Therefore, many diseases, especially cancer, occur in advancing ages. Crew planning departments of companies create programs for monthly and annual flight planning under certain limits. With the world's temperature values above the average at certain time intervals, the current radiation limits can be filled even in much shorter flight times.

Another important issue to be considered while the aircraft is in a closed hangar is the effect of radiation or strong electromagnetic field. In particular, the radiation effect is emitted from the electronic compartment and the radar in the nose. This effect causes health problems for personnel working in the radar field. For this reason, care should be taken that the radar does not operate when the electronic or electrical system of the aircraft is operated. Efforts should be made to minimize exposure to the electromagnetic field.<sup>13</sup>

### Ergonomic factors

Ergonomics should be used to ensure proper efficiency and safety in every part of our lives. The design of an aircraft should aim to reduce human errors, and the machine should be capable of eliminating human errors. It is important to accept the inevitability of human error. No one; whether he is a designer, engineer, manager, maintainer or pilot, he cannot act perfectly all the time. A performance that is considered excellent for one manager may not be considered so for another. Therefore, people need to appear as they really are. It is futile to want them to be better and different. But such a wish; better education, training, experience, motivation etc. It can be realized by providing the factors that affect human factors.<sup>14</sup>

Luggage carriers are at risk of musculoskeletal diseases. They spend long hours standing and working in awkward body postures, lifting heavy luggage from conveyors to carts and luggage containers to carry it onto the plane. Lifting heavy luggage can lead to various ergonomic hazards, resulting in injury. Check-in staff also face ergonomic hazards. This can cause fatigue and back pain, as they often stay in front of the computer for long periods of time. They lift heavy luggage onto the conveyor and do repetitive work.

Flight crew are at risk of musculoskeletal injuries related to the shoulder, neck and lower back. The risk is related to the amount of work overhead lying, lifting, pushing, pulling, twisting and twisting, and awkward body postures. Risk areas for musculoskeletal injuries include:

- Handling heavy luggage
- General access requirement for utensils and upper cabinets in the kitchen
- Poor seating conditions for flight attendants
- Standing for a long time
- The need to bend and crouch to reach items inside the trolleys and kitchen

- Maneuvering requirement of pulling, pushing and service trolleys
- Turbulence
- Closed area
- Aircraft takeoff and landing

The narrow working areas of the aircraft create an uncomfortable working area for the personnel. Fault response operations can take hours, especially with military aircraft, and personnel often have to perform their duties on their knees, crouching or getting stuck in tight spaces. Although passenger planes are large-bodied, similar problems are encountered in these planes as well. Occupational musculoskeletal disorders are a very common health problem in industrial enterprises, since work places employees at different risks in workplaces with poor ergonomics. Musculoskeletal disorders are among the main causes of decreased work efficiency, lost work days, fatigue and injuries.<sup>15</sup>

Many aviation companies have adopted a shift work system. Many workers in these busy and long shifts have a working environment with low ergonomic comfort. Especially in certain parts of the year, with the increase in flight frequencies, these physical risks increase and their effects continue in daily life. Since the effects on the employees are long-lasting, sufficient sensitivity is not shown by the newly recruited employees.<sup>16</sup>

### Occupational diseases in the aviation industry

Aviation sector employees may encounter a wide variety of occupational diseases depending on their activities. In this regard, according to Document 8984 "Civil Aviation Medicine Handbook" published by ICAO, states should conduct medical evaluations on licensed personnel as part of their state security program. One of the purposes of the assessment process is to identify and focus on areas of increased medical risk.<sup>17</sup> When we look at occupational diseases caused by physical risk factors in the aviation sector:18

**Cabin Air Quality:** Hazards related to the ventilation system, passengers and pressure changes are thought to cause various diseases. In addition, viruses from certain parts of the world or diseases that can be transmitted from passengers also pose a risk for the flight crew.

**Cancer:** Flight crew are exposed to above-normal levels of cosmic radiation. Studies reveal that flight crew are more likely to encounter melanoma and other types of skin cancer. However, the findings showed that female cabin attendants encounter breast cancer more frequently than the general population.

**Musculoskeletal Disorder:** Musculoskeletal disorders are short- or long-term injuries to the nerves, tendons, muscles, and supporting structures of the body such as bones and ligaments. Flight crews face various problems such as pain, swelling, stiffness and numbness due to various lifting, pushing, pulling, and standing for a long time in the cabin.

**Hearing Loss:** Occupational hearing loss is one of the most common occupational diseases. Aviation industry employees are also exposed to high amounts of noise for a long time. This increases the likelihood of hearing loss.

**Reproductive Health:** It has been observed that cosmic radiation, circadian rhythm disturbance and physical difficulties such as heavy lifting and bending over the job adversely affect reproductive health. According to a study by the National Institute of Occupational Safety and Health, standing for more than 8 hours and bending the waist more than 25 times a day increases the risk of miscarriage during pregnancy.



## Risk management and process

Risk Management can be defined as the determination and evaluation of all kinds of risks in the workplace, the examination of the causes of occupational accidents and occupational diseases and the evaluation of the active factors, the elimination of the risk factors determined in the light of this information gathered, or the planned activities to reduce the degree of impact.

The main purpose of the Occupational Safety management system is to reduce or completely eliminate the sources of danger from the working conditions in the workplace and the risks that threaten the health of the employees.

While performing risk analysis, it is tried to eliminate or reduce the risks to the least effect by going through many stages. These stages aim to reach the best in a cycle due to continuity.

The first of these stages is research and observation; The equipment to be used, the way of working, the choice of chemicals used, the places that will affect the employees such as the workplace layout and the protection levels are taken into consideration.

The next step is to identify the hazards. All adverse conditions should be evaluated and recorded, taking into account all hazards present in the workplace. These, previous accidents, near misses, occupational diseases, physical and psychological health hazards, previously created reports, tables, documents, in short, hazards should be defined using all available data.

The third stage is risk identification and the aim at this stage is; is to prevent the occurrence of the risk completely or to prevent the risk that has already occurred from reaching the employees.

Finally, the risk assessment and interpretation phase. The priority is to avoid very dangerous risks. The stage where necessary measures are taken, correction, improvement, development of new methods such as replacing other equipment and chemicals, and editing begins at this point. It is necessary to rank and evaluate the risks, to carry out measurements and controls, to carry out additional risk controls, to check whether the measures deemed appropriate to be taken are sufficient and whether they create new risks. At this stage, the probability of events occurring and the consequences that may be incurred when they occur are determined.<sup>19</sup>

## Conclusion

The most common physical risks in aviation workers are examined under 4 headings as noise, vibration, cosmic radiation and ergonomic factors. As a result of these risks, many employees lose their jobs temporarily or permanently. Especially with the liberalization of aviation in recent years, many new companies have been included in the sector. Companies use different contracting techniques with their employees. Employment is provided through collective bargaining agreements, seasonal agreements or subcontractors. Time pressure, which is undoubtedly one of the most important pressure elements of the aviation industry, brings risks. The race of the companies with time is reflected on the employees and physical risks with negative consequences occur. Businesses that intend to increase their profitability and efficiency can ignore these physical risks. Planning of field applications is of great importance for ensuring flight and employee safety. In order for the maintenance to be carried out on time and safely, first of all, the hazards in the work should be determined. It should be aimed that the measures to be taken against the hazards are compatible with the technology and applicable by the maintenance workers. Otherwise, it will not be possible to implement the plans

made in the studies in aircraft maintenances that race against time. For Occupational Health and safety, the priority should be to take protective measures and make the necessary work plans. Precautions should be taken in the system and the execution of the system should be followed. Spending is always cheaper and more humane than paying.

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## Conflicts of interest

Authors declare that there is no conflict of interest.

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