Summary of the Congressionally Mandated Report, *Health Effects of Jet Fuels Used by Armed Forces*

Executive Summary

The report *Health Effects of Jet Fuels Used by Armed Forces* looks at how jet fuel exposure affects the health of military personnel. The PACT Act, passed in 2022, asks the Department of Veterans Affairs (VA) to study how jet fuels impact the health of Veterans. This report specifically focuses on the types of jet fuels used by the Armed Forces, the health risks linked to exposure, the safety measures put in place by the Department of Defense (DoD), and the areas where further research is necessary.

Military personnel can be exposed to jet fuels by breathing in fumes, getting it on their skin (where it can be absorbed), or accidentally swallowing it. Jet fuels have harmful chemicals that can lead to problems like memory loss and hearing issues. Exposure to jet fuels can also cause trouble breathing and lung damage. While some research suggests a link between jet fuel exposure and cancers, like kidney and bladder cancer, more studies are needed to prove these risks.

DoD has worked over the years to protect military personnel from jet fuel exposure. They have added better air systems, provided gloves and masks, and trained people on safe ways to handle jet fuels. These safeguards have been updated as more information about the dangers of jet fuel exposure has become available. For example, in recent years, new types of protective gear and better safety procedures have been introduced to reduce the risks of working with jet fuels.

More studies are needed to better understand the long-term health risks of jet fuel exposure. Current research shows slight evidence of health effects in several areas. This includes issues with the nervous system, like lower performance on memory tests, hearing problems, and eye conditions. There is also slight evidence of effects on mental health, such as problems with attention, thinking, social behavior, depression, and visual-spatial skills. For the respiratory system, there is slight evidence that jet fuel exposure may lead to reduced lung function, more breathing problems, and symptoms like shortness of breath, coughing with mucus, and a stuffy or runny nose. There was also a connection to certain cancers, like kidney and bladder cancer, although small studies and other weaknesses in the research limit these findings.

Despite these findings, many gaps remain. Studies often have small sample sizes, lack long-term follow-up, or do not account for other factors that might affect health. More research is needed to confirm these links, explore how long-term exposure affects health, and find out if early symptoms can predict future problems. Researchers also need to study underrepresented groups, like women and minority Service members and Veterans, to ensure findings apply to everyone. Filling these gaps will help better protect the health of those exposed to jet fuel during their service.

Introduction

Overview of the PACT Act

The PACT Act, signed into law in 2022, was created to expand benefits and healthcare for Veterans exposed to toxic substances during military service. This includes exposure to jet fuels, which is common for personnel working around aircraft. Section 510 of the PACT Act required VA to report to Congress on how jet fuels affect the health of military personnel. It required VA to review the types of jet fuels, how length of exposure impacts health risks, early symptoms that may be related to long-term health problems, and ways the DoD has tried to protect Service members from exposure.

To complete this report, VA collaborated with DoD. This partnership provided access to important data and studies on jet fuel exposure and its effects on military personnel. DoD also supplied information on health policies that were put in place to protect those working with jet fuels. VA is leading studies to improve understanding of jet fuel exposure in the military and the related long-term health effects. This report is a condensed version of the full Congressionally Mandated Report (CMR), designed to make the information accessible to Veterans. The full report can be accessed at: https://www.govinfo.gov/app/details/CMR-VA1-00189958.

Types of Jet Fuels

The military uses different types of jet fuels. These fuels are made mostly of kerosene, with added chemicals to make them work better and be safer. Below are the most common types of jet fuels used by the military:

- *JP-4:* Introduced in 1951, JP-4 is a kerosene-based fuel designed for military use. However, JP-4 is highly flammable, and its use has decreased over time, as safer alternatives have been developed.
- *JP-5:* Introduced in 1952, JP-5 is used on aircraft carriers due to its higher flash point. This higher flash point reduces fire risks during naval operations.
- *JP-8:* Developed in 1978, JP-8 is a safer and less flammable alternative to JP-4. It became the standard fuel for military aircraft in the 1990s and is still widely used today. Like JP-5, JP-8 contains additives to reduce the risk of corrosion, improve lubrication, and prevent freezing at high altitudes.
- *Jet A:* Jet A is primarily used in commercial aircraft but is also the base fuel for JP-8. It has a slightly different chemical composition and is used in both military and civilian aviation.

Each of these jet fuels contains some toxic chemicals, such as benzene and toluene, but at very low concentrations. Jet fuels may be harmful when inhaled, absorbed through the skin, or ingested. These fuels are highly volatile, and military personnel working around them are at risk of exposure, especially if they are not using proper protective equipment.

Health Safeguards Implemented by DoD

Introduction to Health Safeguards

Health safeguards are measures used to protect military personnel from the harmful effects of jet fuel exposure. These safeguards help reduce the risks of breathing in fumes, touching the fuel, or accidentally ingesting it. Jet fuels contain hazardous chemicals that can harm the body. DoD has developed protective measures to reduce these risks. These safeguards have improved over time as more was learned about the dangers of jet fuel exposure.

Early Safeguards (Pre-1990)

Before the 1990s, the health safeguards used to protect personnel working with jet fuels were basic. Workers who handled fuels were required to wear gloves, coveralls, and face shields. The goal was to prevent skin contact with the fuel, which could cause irritation or burns. Firefighting equipment was available, as the fuels were highly flammable, and immediate dangers like fires were a top concern.

1990s: Improved Safety Measures

By the 1990s, concerns grew about the long-term health risks linked to jet fuel exposure. DoD introduced more comprehensive safeguards, including both better protective gear and updated training programs. Protective equipment continued to include gloves and coveralls, but there was now an added focus on reducing the amount of fuel fumes personnel could inhale.

Ventilation systems were installed in enclosed spaces where fuels were stored or handled. These systems reduced the buildup of harmful vapors in the air. This change made it safer for personnel to work in areas like fuel storage rooms and maintenance facilities. During this time, emergency eyewash stations were also installed in certain work areas. This allowed workers to wash off any fuel that splashed on their skin or got into their eyes quickly and safely.

Training programs were also updated in the 1990s to educate personnel on safe fuel-handling practices. Workers were trained on how to properly refuel aircraft, store jet fuel, and transport it safely. These training programs helped reduce the chances of accidents and ensured that personnel knew how to protect themselves from exposure.

Routine medical checkups for workers exposed to jet fuel were introduced during this period as well. Regular health screenings made it possible to detect early signs of exposure-related health problems, such as respiratory issues or skin conditions. This allowed for quicker treatment and prevention of more serious health problems.

2000s: Focus on Respiratory Protection and Systematic Safety

In the 2000s, more attention was given to protecting workers from the harmful effects of breathing in jet fuel vapors. DoD introduced more advanced respiratory protection. Air-purifying respirators became more common for personnel working in enclosed areas where fuel vapors could build up. These respirators helped prevent workers from inhaling harmful chemicals.

Along with better respiratory protection, new rules were put in place for regular inspections of fuel-handling equipment. These inspections helped ensure that equipment was in good working condition, preventing leaks or spills that could lead to dangerous exposures. More detailed emergency response plans were also developed. These plans gave workers clear steps to follow in case of an accidental spill or fuel leak. Training was expanded to teach personnel how to safely handle hazardous materials and how to react during an emergency.

Medical surveillance programs were also improved during this period. Workers who were regularly exposed to jet fuels had more frequent health checkups to identify conditions like respiratory diseases or skin issues before they worsened. This regular monitoring was essential in preventing long-term health effects from continuous exposure.

2010s: Advanced Protective Equipment and Engineering Controls

By the 2010s, research into jet fuel exposure led to the development of even better health safeguards. This included more advanced personal protective equipment (PPE). The gloves and coveralls provided to personnel were made from flame-resistant materials that also protected against chemical exposure. Breathing protection became more advanced, with newer, more effective, air-purifying respirators used in areas where dangerous vapors were present. Workers also used special breathing equipment in high-risk areas to stay better protected.

Engineering controls also became more advanced during this time. New technologies, such as automated fuel systems, were introduced, reducing the need for workers to come into direct contact with jet fuels. Ventilation systems were also upgraded in fuel storage areas to further reduce vapor buildup. These engineering controls significantly lowered the risks of exposure by limiting the chances of fuel leaks, spills, or dangerous vapor concentrations in the air.

Safety manuals were updated to ensure that personnel understood the latest safety procedures. These manuals explained how to handle fuels safely, how to maintain equipment, and how to properly use PPE. Workers received regular training on these updated procedures, ensuring that safety standards were followed at all times.

Current and Future Health Safeguards

Today, DoD continues to improve its safeguards to protect personnel from jet fuel exposure. The combination of advanced PPE, upgraded engineering controls, and

extensive safety training provides military workers with strong protection. PPE materials have become more resistant to chemicals, and new designs offer greater protection against both skin contact and inhalation risks. Ventilation systems and automated fuel-handling equipment further reduce the chances of workers coming into contact with harmful fumes.

Future health safeguards are expected to be based on ongoing research into the combined effects of chemicals in jet fuel. As more is learned about how these chemicals affect the body, new safeguards will likely be developed to further protect workers. These may include new types of protective equipment, advanced engineering controls, or updated safety procedures.

Health Effects of Jet Fuel Exposure

The health effects of exposure to jet fuel have been studied, though the evidence varied in strength across different organ systems and health outcomes. This section explored the possible health impacts linked to jet fuel exposure, including effects on the nervous system, respiratory system, behavioral health, cancer risks, and other body systems. The strength of evidence for each health outcome varied, and there were very few studies available. Many of these studies had limitations, such as small sample sizes or lack of long-term follow-up. However, the available data provided some insights into the health risks associated with jet fuel exposure.

Nervous System Health Effects

There was slight evidence linking jet fuel exposure to problems with the nervous system. Military personnel exposed to jet fuel vapors might have experienced memory loss and hearing impairments. Research showed that individuals exposed frequently to jet fuel vapors may have performed poorly on memory tests, and slower reaction times were noted in some studies. Hearing loss was also reported, but the role of noise exposure from the work environment complicated these findings. While these studies provided some insight into nervous system issues, the evidence remained weak because other factors like noise and stress could have contributed to the effects observed. Additionally, the long-term consequences of these neurological effects were not well understood because most studies focused on individuals who were currently exposed, rather than those who had been removed from exposure for an extended period.

There was also evidence suggesting that jet fuel exposure could affect motor function. Some studies showed that individuals with long-term exposure to jet fuels had difficulty with tasks requiring coordination and fine motor skills. These findings were of concern because such impairments might not always be immediately noticeable. Over time, these deficits could affect job performance and daily activities. However, further research would be necessary to clarify the extent and permanence of these motor skill impairments.

Behavioral and Mental Health Effects

Exposure to jet fuel was also found to potentially affect mental and behavioral health. Several studies have explored the possible links between jet fuel exposure and attention problems, cognitive function, and mood disorders like depression. These studies suggested that people exposed to jet fuel might have had difficulties with attention, thinking skills, and emotional regulation. For example, individuals exposed to high levels of jet fuel showed signs of shorter attention spans and trouble with tasks that require visual or spatial skills. Depression was also reported more frequently in those who work closely with jet fuels.

However, like the nervous system findings, the evidence for mental health outcomes was weak. Most studies on mental health effects were based on self-reported symptoms and involved small groups of participants. There was also little information on whether these symptoms persisted after exposure ended or developed into more serious long-term mental health problems. Thus, while there was some evidence linking jet fuel exposure to mental health issues, more robust research would be needed to draw firm conclusions.

Respiratory Health Effects

The respiratory system was one of the primary routes of exposure to jet fuel, and several studies looked at how it might have affected lung function. Some evidence suggested that jet fuel exposure could have led to reduced lung function and an increase in respiratory symptoms, such as coughing, difficulty breathing, and nasal congestion. These symptoms were particularly common in people who worked in enclosed spaces where fuel vapors can accumulate.

There was also a possibility that jet fuel exposure might have been linked to the development of obstructive lung diseases, such as chronic bronchitis. However, there were very few studies that reported on this condition, and the evidence was not strong enough to confirm a definite connection. Most studies focused on short-term respiratory effects, and there was little data on how these symptoms progressed over time, especially after exposure had ended. As a result, the long-term impact of jet fuel on respiratory health remained unclear.

Cancer Risks

Some research suggested that jet fuel exposure might have increased the risk of developing certain cancers, including kidney and bladder cancer. Workers who were exposed to jet fuel fumes regularly might have had higher rates of these cancers, although the data were not conclusive. In many studies, it was difficult to separate the effects of jet fuel exposure from other risk factors, such as smoking or exposure to additional harmful chemicals. This made it challenging to confirm a direct link between jet fuel exposure and cancer risk.

Kidney cancer, in particular, had been highlighted as a concern among workers exposed to jet fuels. The toxic chemicals found in jet fuels can be absorbed through the skin or inhaled, potentially leading to damage to the kidneys over time. Studies that evaluated bladder cancer suggested that prolonged exposure to the chemicals in jet fuels might have contributed to cellular changes in the bladder that could result in cancer development. However, more detailed research would be required to establish a clear connection between jet fuel exposure and these cancers.

Other Body Systems

Jet fuel exposure could potentially affect other parts of the body, but there was not enough scientific evidence to draw any conclusions. For some body systems, such as endocrine or metabolic systems, no studies were available to evaluate potential effects in workers.

Length of Exposure

One of the key factors in determining the health risks associated with jet fuel exposure was the length of time a person had been exposed. Unfortunately, most of the studies reviewed did not provide detailed information about how the duration of exposure affected the risk of developing health outcomes. Several of the studies included workers who were actively being exposed to jet fuels and did not track these individuals over time to see how their health was impacted after exposure ended. As a result, it was difficult to determine whether being exposed to jet fuels for longer periods increased the risk of health problems compared to shorter exposures.

Some studies provided general information about the average length of employment for workers exposed to jet fuels, but they did not analyze how short-term exposure differs from long-term exposure. For example, workers who had been in their jobs for several years might have experienced different health effects compared to those who have only worked with jet fuels for a few months, but there was not enough data to confirm this. Without more information, would be challenging to understand how exposure time contributed to long-term health risks.

Immediate Symptoms and Future Health Risks

Jet fuel exposure could cause a range of symptoms that appear shortly after contact with the fuel. These symptoms often include dizziness, headaches, nausea, eye irritation, and difficulty breathing. Workers could also experience skin irritation if the fuel comes into direct contact with their skin. These effects tend to develop quickly and are usually linked to either inhaling the vapors or through physical contact with the fuel. For some individuals, the symptoms are temporary and resolve once they are no longer in the area of exposure. Others may experience symptoms that last longer or require medical attention, especially in cases of prolonged exposure to high concentrations of jet fuel vapors.

One of the challenges with understanding these immediate symptoms is determining whether they could signal future health problems. The evaluated studies did not offer strong evidence to confirm if early symptoms, like headaches or skin reactions, are indicators of more serious, long-term health conditions. For example, while dizziness and headaches were common in those exposed to fuel vapors, it was unclear if these symptoms increased the likelihood of developing chronic health problems, such as respiratory diseases, neurological disorders, or cancers, later in life. Most studies did not follow exposed individuals over time to observe if these early symptoms evolved into more severe conditions.

Additionally, some studies suggested that frequent episodes of acute symptoms could potentially lead to more persistent health issues, especially in workers who were exposed repeatedly to jet fuels. However, this link has not been established with certainty. Further, the available data did not provide a clear picture of whether workers who experienced frequent or intense symptoms were at a higher risk of developing long-term health effects compared to those who only experienced mild symptoms. Therefore, it was difficult to predict long-term outcomes based on initial reactions to exposure.

Data Gaps

The available studies on jet fuel exposure provided some insights into health risks but also left many important questions unanswered. One of the most critical gaps identified during the review was the lack of that examined how the duration of exposure affects health outcomes. Without understanding how the length of time someone was exposed to jet fuel impacted their health, it would be difficult to develop clear guidelines for to reduce risk.

There were also gaps in understanding how jet fuel exposure affects various body systems. While there was some evidence linking occupational jet fuel exposure to neurological, behavioral, and respiratory effects and certain cancers, other systems like the reproductive, endocrine, and immune systems had not been studied in detail. More research would be needed to determine whether these systems would also be affected by exposure and if so, how.

There was a shortage of data on the immediate symptoms that could indicate future health risks. Early symptoms, such as dizziness, headaches, and respiratory problems, were noted, but there was insufficient research to determine if these initial signs could predict more serious, long-term health issues. The ability to identify early indicators would allow for quicker intervention and treatment, potentially reducing the risk of chronic conditions later in life.

Another major limitation in the current body of research was the difficulty in accurately measuring exposure levels. Many studies relied on self-reported data or job titles to estimate exposure, which can introduce errors. A more precise method of measuring both the intensity and duration of exposure would be needed to accurately link jet fuel

exposure with health outcomes. Improved exposure assessments would also help identify whether specific fuels or additives are more harmful than others.

Additionally, there was limited research on how jet fuel exposure affected certain populations. Most studies focused on male military personnel, leaving gaps in understanding how exposure might have affected women and minority groups. Differences in body size, metabolism, and hormone levels could mean that these groups experience different health risks, but there was currently not enough data to draw conclusions. Future studies should aim to include more diverse populations to ensure that findings apply to all Veterans.

Finally, the interaction between jet fuel exposure and other environmental or occupational hazards was not well understood. Military personnel are often exposed to multiple toxic substances simultaneously, which could amplify health risks. Studies that examined how jet fuel exposure interacted with other hazards could provide a more complete picture of the risks faced by service members and Veterans.

Overall, while the available studies provided some insights into the health risks of jet fuel exposure, many gaps remained. Addressing these gaps will require more long-term studies, better exposure measurement methods, and a focus on underrepresented populations and body systems. Filling these gaps would be essential to understanding the full impact of jet fuel exposure on Veterans' health.

Conclusion

This report provides an overview of the health effects related to jet fuel exposure among military personnel, the safety measures implemented to reduce exposure, and the gaps in current knowledge. Research has shown slight evidence linking jet fuel exposure to specific health outcomes. This includes issues with the nervous system, like lower performance on memory tests, hearing problems, and eye conditions. There is also slight evidence of effects on mental health, such as problems with attention, thinking, social behavior, depression, and visual-spatial skills. For the respiratory system, there is slight evidence that jet fuel exposure may lead to reduced lung function, more breathing problems, and symptoms like shortness of breath, coughing with mucus, and a stuffy or runny nose. There was also a connection to certain cancers, like kidney and bladder cancer, although small studies and other weaknesses in the research limit these findings.

To minimize exposure risks, DoD has introduced various safeguards over time, including protective equipment, ventilation systems, and training programs. However, more research is needed to clarify the effects of exposure duration, the combined impact of chemicals in jet fuel, and potential risks to underrepresented populations, such as women and minority groups. Addressing these gaps is crucial to improving the health and safety of military personnel and Veterans.