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## A Clinician's Guide to Occupational Exposures in the Military

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### Abstract

**Purpose of Review:** Adverse occupational and environmental exposures are common causes of respiratory disease and health consequences requiring medical care. Understanding how these various exposures effect patients and how to elicit an adequate history is critical for any clinician. Military personnel are often overlooked when discussing groups at risk for environmental exposure-associated airway disease. There are close to 20 million active duty and veterans in the United States and nearly all clinicians will at some point care for a patient that has served in the military.

**Recent Findings:** Exposures related to military work include burn pits, chemicals/toxins, sandstorms, living conditions among others. Burn pits and military waste are increasingly recognized as potential hazards attributed to the ongoing conflicts in the Middle East. The link between these various military exposures and acute or chronic airway diseases remains difficult. Epidemiological studies are emerging to demonstrate correlations with chronic lung disease and prolonged burn pit exposure.

**Summary:** This review provides an overview of potential occupational and environmental exposures that may affect current and/or former military service men and women.

### Keywords

Occupational exposure; Military exposure; Burn Pits; Occupational Respiratory disease

### Introduction

There are more than 1.3 million active-duty military personnel and more than 800,000 reserve forces in the United States. This includes over 200,000 personnel deployed overseas. [1] Many of these individuals are exposed to various hazards that may adversely affect their health. Exposures range from particulate matter such as blowing sand, smoke from burn pits used for waste disposal and urban smog to mold exposure in on-base housing.[2–3] In addition, military personnel, like the general population, have underlying medical conditions that increase their risk for complications from occupational exposures. Service members with well-controlled asthma can continue to serve in active duty and these men and women may, therefore, be at higher risk for adverse outcome.[4] While asthma prevents entrance into the military, under-diagnosis at the time of enlistment is common.[5]

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When caring for veterans, medical providers must keep in mind unique exposures not only from current wars and conflicts but from prior wars. US Navy vessels built prior to 1980 were laden with asbestos and veterans of the Vietnam war may still present with cancers from Agent Orange exposure. Many clinicians may be accustomed to taking a thorough history of current exposures but exposures from 30 years ago can be easily forgotten. This review article provides a list of common exposures that a provider may encounter when treating US service men and women.

## Burn Pits

The term burn pit is used in the military to refer to areas where solid waste is burned outside in the open air. This waste may include wood, chemicals, munitions, metal, medical and human waste, plastics, electronics, rubber and food among other trash. Burn pits have long been used by the military but gained increasing notoriety during the wars in Iraq and Afghanistan (Figure 1, Burn pit photo). Typically, materials are set in piles, rows or holes in the ground and ignited with jet fuel. Burn pits are not without their benefit as they helped reduced the spread of infectious diseases. In addition, transporting waste to proper disposal facilities like landfills or incinerators can be dangerous in combat zones. However, this waste removal technique also releases smoke and potentially debris that is toxic to both the environment and personal health. These effects have resulted in multiple lawsuits from veterans, Department of Defense Civilians and military contractors.[6] During their peak in 2010, there were 273 active burn pits reported at military bases in Iraq and Afghanistan.[7] It was around this time that burn pits started to be phased out of military practice. As of July 2019 there were only 9 active burn pits found in Syria, Afghanistan and Egypt.

It is difficult to define an individual's exposure to the burn pits and its potential for harmful effects. There is limited monitoring of burn pits and uncertainty about materials burned at any given time. There is also no defined "safe distance" from one the pits. There are several factors that may influence a person's risk which include the duration of time spent and distance to the burn pit, the type of waste material (e.g. plastics, electronics and medical waste are of higher risk), seasonal weather patterns and wind direction, and personal medical history. Up until recently there was limited data directly linking burn pits to long-term disease, although there has long been known risk from many of the chemicals found in burn pits. The Institute of Medicine formed a committee on Long-term Health Consequences of Exposure to Burn Pits in Iraq and Afghanistan in 2010. They compared people within two miles of burn pits to those stationed further than two miles. Their initial review of the literature only showed limited evidence to suggest an association between burn pit exposure and reduced lung function.[8] The evidence for chronic lung disease is changing as larger epidemiologic studies are being completed.[9–10]

The Veterans Affairs (VA) established the Airborne Hazards and Open Burn Pit Registry (AH&OBP) in 2014. This registry has over 200,000 participants now which has allowed for more robust data collection.[11] This registry is a voluntary database whereby veterans can submit their exposure and any health concerns through an online questionnaire. Additionally, there is a nonprofit registry founded in 2010 ([burnpits360.org](http://burnpits360.org)), which has more expansive medical questions.[12] Recent data from this registry has shown exposure

to burn pits has significant association with a higher risk of self-reported emphysema, chronic bronchitis and chronic obstructive lung disease.[13] A recent retrospective cohort study (n=55,760) showed a significantly elevated rate of respiratory symptoms (incidence rate ratio of 1.52) as well as asthma (incidence rate ratio of 1.61) in military personnel deployed to Kabul, Afghanistan as compared to military personnel stationed in other parts of the world.[14] Interestingly, this study did not find an increased rate of chronic obstructive pulmonary disease, which is in contrast with some of the previous registry findings. It is also likely that more evidence of chronic lung disease will emerge as time from exposure elapses. Further longitudinal studies are likely needed with serial measurements of pulmonary function as well as exploration of potential novel biomarkers.[15]

Exposure to particulate matter has long been known to be a risk factor for lung disease and death.[16–17] Burn pits produce a high concentration of particulate matter due to slow burns at low heat. Burn pits release particulate matter levels that are higher than are what are generally considered safe by U.S. regulatory agencies.[18–19] In addition to generally high levels of particulate matter, there is a higher concentration of potentially toxic material. Ambient levels of the toxic chemicals including polycyclic aromatic hydrocarbon, polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans have all been found in high concentrations at military bases.[20] The main source of these chemicals is the burn pit.

Aside from chronic lung disease there are other potential risks posed by burn pits. Increased exposure to particulate matter has been shown to have adverse effects on birth outcomes including low birth weight and preterm delivery. As noted above, burn pits release high levels of dioxins which have been linked to neural tube defects. However, studies have not consistently shown a direct link between poor birth outcomes and burn pit exposure.[21] The AH&OBP registry has also shown an increase in rates of self-reported hypertension, insomnia and liver disease.[22] The relationship between chronic rhinitis and/or sinusitis attributed to burn pit exposure has not been well-described in the literature but would be interesting to capture to inform therapeutic approaches. The Kuwait Registry, comprised of Persian Gulf War veterans, reported that one of the most frequent diagnoses of medical symptoms related to the head and neck was chronic sinusitis.[23] There was also high development of chronic rhinosinusitis disease following exposure to the dust clouds of the World Trade Center collapse of 2001.[24] Future studies could be warranted to investigate the association burn pits and their respective toxin exposures on upper airway disease manifestations.

On August 10<sup>th</sup>, 2022, legislation known as the Pact Act was signed that expands medical care eligibility to veterans exposed to burn pits. The legislation will allocate an estimated \$280 billion over the next 10 years to any service member stationed in a combat zone over the last 32 years.

## Noise Pollution

Hearing loss and military service has long been linked and is only increasing with recent military conflicts.[25–26] Hearing loss is the most common service-connected disability and results in over \$1 billion annually in Department of Veteran Affairs compensation. [27–28]

Factors that contribute to hearing loss include high intensity noise from ammunition fire, detonation of explosive devices, construction sites and urban living. Of soldiers returning from Iraq or Afghanistan, 71% report exposure to loud noise and more than 15% report ringing in their ears. [29]

The Millennium Cohort Study was launched in 2001 and was designed to assess the health of military personnel over the course of at least 21 years. A study of this cohort has shown 7.5% of participants have self-reported new-onset hearing loss. Self-reported hearing does correlate with objective audiometric measures. Further, new-onset hearing loss was associated with combat deployment, male sex, older age and proximity to improvised explosive devices.[30] Military personnel returning from combat have a 63% increased risk for hearing loss [31] which indicates the need to screen these patients upon return from service. Multiple screening programs are available and referral to an audiologist or otolaryngologist should be considered for many of these patients.[32]

## Prior Deployment Exposures

Although certain military exposures no longer exist, recognizing their role in potentially mediating disease in treating veterans is important due to the long-term impacts. For example, Agent Orange is an herbicide that was used primarily during the Vietnam War in Vietnam and Malaysia. The United States used it to remove large areas of foliage and trees. The military sprayed millions of gallons of Agent Orange during the war that led to both devastating environmental and health effects. One of the primary problems with Agent Orange is the high level of dioxin. The people of Vietnam suffered the worst of the exposure with one estimation of up to 3 million people suffering from illness caused by the chemical, including children. There is still elevated soil contamination of dioxin in parts of Vietnam over 30 years after the war, including on military bases.[33] There is a clear link with dioxin and birth defects, however, the degree to which Agent Orange exposure in Vietnam is associated with birth defects remains controversial.[34] Agent Orange has also been associated with multiple cancers including soft tissue sarcoma, Non-Hodgkin lymphoma, chronic lymphocytic leukemia, Hodgkin's lymphoma and multiple myeloma. [35–37] There has not been a clear link with chronic respiratory disease, however, there may be an association with lung cancers.[38]

Asbestos was widely used by the Navy during World War II in shipbuilding and continued to be used up until the 1980's. Since the 1930's, asbestos has been recognized to elicit lung disease and was linked to lung cancer in the 1950's.[39] The US Navy workers continued to have exposure up until the 1980's, and therefore, obtaining military exposure history is critical because the development of mesothelioma can be delayed for decades following exposure.

At the close of the Gulf war in 1991, retreating Iraqi soldiers ignited more than 600 Kuwaiti oil wells. Thousands of US troops were enveloped in large amounts of thick, black smoke. Many of these veterans have later reported various respiratory symptoms presumed to be from a direct cause of this exposure. Similar to burn pits, oil well smoke contains potential carcinogens including benzene and polycyclic aromatic hydrocarbons. In contrast to burn

pits, however, oil well smoke produces low amounts of these chemicals.[40] Oil well fire smoke also appears not to have observable changes in lung tissue based on autopsy reports when comparing soldiers exposed and not exposed to the smoke.[41] Finally, epidemiologic studies have not been able to confirm a link between oil well smoke and chronic respiratory disease.[42]

## Miscellaneous military exposures

Sandstorms are a common occurrence in the Middle East and almost unavoidable for military personnel deployed to this region. Masks are made available to soldiers but are often not worn due to heat. Sandstorms are a source of increased dust, air pollution, bacteria, mold and allergens. Dust collected near a military base in Iraq compared to dust in California showed higher concentrations of endotoxin and trace metals. In addition, when the dust was exposed to lung epithelium chronically, the inflammatory response increased dramatically.[43] Sandstorms produce acute exacerbations of asthma as well as a myriad of other complaints including cough, rhinorrhea, headache, body aches and sleep disturbances. [44] Chronic exposure may also lead to an increase in chronic lung disease. Asthma, intermittent laryngeal obstruction, rhinosinusitis and decreased diffusion capacity are all increased in patients deployed to the Middle East.[45]

Chemical warfare was first used in modern warfare during World War I even though international treaties had already existed banning their use. The use of chemical warfare has dramatically declined in recent conflicts; however, chlorine attacks were used by Iraqi insurgents during Operation Iraqi Freedom.[46] Chlorine reacts with water to produce hypochlorous and hydrochloric acid. These acids cause irritation to the airways. Typically, symptoms resolve within 3-5 days, however, there are reports of this causing long-term damage.[47] Fortunately, exposure to chemical warfare has been relatively uncommon for US military personnel.

Occupational exposures in the military often focuses on deployment and risks associated with foreign combat service. There are still exposures that can be seen in those stationed stateside. There are certain diseases that need to be considered in endemic parts of the country. For example, a provider seeing a patient in the Northwest may not be accustomed to considering coccidioidomycosis in a patient presenting with fever, but this should be considered for someone recently stationed in the Southwest United States.

The military also provides on-base housing to approximately one-third of all military personnel. Even though this housing is on a military base it is managed by private institutions, which has led to some examples of poor quality in some locations. An investigation by the Army Inspector General office in 2019 found severe deficiencies and safety risks with housing.[48] The report found that roughly two-thirds of surveyed residents expressed dissatisfaction with their housing experience and 52% expressed environmental concerns. Problems included vermin infestations, lead paint, asbestos and mold exposure. Following the report's release, there were efforts made to mitigate some of these problems, but budget constraints and legal hurdles remain.[49] A summary of these potential occupational exposures in military personnel is provided in Table 1.

## Conclusions

There is a vast array of unique occupational exposures that medical providers need to consider when dealing with active-duty military personnel and veterans. Often there needs to be a multispecialty approach including, among others, primary care providers, pulmonary or allergy specialists, otolaryngologists, physical therapists, occupational therapists and psychiatrists. Understanding the nature of exposures is a first step to appropriately caring for this population. There have been recent advancements in the recognition and assessment of military exposures. Previously, study of exposures was limited to questionnaires and surveys which were deemed inadequate. [50–51] The military is now adopting new techniques to study the totality of exposures. [52] This involves assessing individuals and specific environments to determine the wide range of potentially hazardous exposures. An additional investigational goal is to assess and define biomarkers associated with exposure and disease consequences. [53] The Department of Defense has a large collection of over 50 million serum samples from soldiers dating back to 1989 which is a vast data source for in assessing potential predictive biomarkers of disease and exposure. An in-depth understanding of not only the type of exposure(s), but how the exposure (s) effect disease development and outcomes is warranted to assure the application of best care practices and institute preventative and/or therapeutic strategies to at-risk military exposed personnel.

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## References

1. Department of Defense website: [dod.defense.gov](http://dod.defense.gov)
2. Falvo MJ Is Deployment an Exposure in Military Personnel? *J Occup Environ Med.* 2014 Nov;56(11).
3. Dept of the Army Inspector General Special Interest Item Assessment of the Residential Communities Initiatives 2019 Mar.
4. Rawlins FA et al. Management of Asthma in the Military. *Fed Pract.* 2015 Sep; 32(10).
5. Nish WA, Schwietz LA. Underdiagnosis of Asthma in Young Adults Presenting for USAF Basic Training. *Ann Allergy.* 1992. 69(3): 239–242. [PubMed: 1524281]
6. South T Supreme Court Rejects Appeal From Veterans in Burn Pit Lawsuit Against KBR, Halliburton. *MilitaryTimes.* 2019. Jan.
7. *Am J Respir Crit Care Med.* Vol. 201, P13–14 2020. [PubMed: 32233853]
8. Long-term Health Consequences of Exposure to Burn Pits in Iraq and Afghanistan. *Institute of Medicine.* Oct. 2011.
9. Banks DE, Bolduc CA, Ali S, Morris MJ Constrictive Bronchiolitis Attributable to Inhalation of Toxic Agents: Considerations for a Case Definition. *J Occup Environ Med.* 2018. Jan 60(1).
10. Abraham JH, DeBaake SF, Reid L, Zhou J, Baird CP. Does Deployment to Iraq and Afghanistan Affect Respiratory Health of US Military Personnel? *J Occup Environ Med.* 2012 June 54(6).
11. US Department of Veterans Affairs. <https://www.publichealth.va.gov/exposures/burnpits/registry.asp>



12. Szema A, Mirsaidi N, Patel B. Proposed Iraq/Afghanistan War-Lung Injury (IAW-LI) Clinical Practice Recommendations: National Academy of Sciences' Institute of Medicine Burn Pits Workshop. *Am J Mens Health*. 2017 Nov; 11(6): 1653–1663. [PubMed: 26669772]
- 13\*\*. Liu J, Lezama N, Gasper J, Kawata J, Morley S, Helmer D, et al. Burn Pit Emissions Exposure and Respiratory and Cardiovascular Conditions Among Airborne Hazards and Open Burn Pit Registry Participants. *J Occup Environ Med*. 2016 58(7).Comment: This study shows ongoing evidence for chronic lung disease pulled from burn pit registries.
- 14\*\*. Sharkey JM, Abraham JH, Clark LL, Rohrbeck P, Ludwig SL, Hu Z, et al. Postdeployment Respiratory Health Care Encounters Following Deployment to Kabul, Afghanistan: A Retrospective Cohort Study. *Mil Med*. 2016 Mar 181(3):265–71.Comment: This study provides evidence that the burn pits are associated with chronic lung disease.
15. Coughlin SS, Szema A. Burn Pits Exposure and Chronic Respiratory Illnesses Among Iraq and Afghanistan Veterans. *J Environ Health Sci*. 2019 Feb 5 (1)
16. Dominici F, Peng RD, Bell ML, et al. Fine Particulate Air Pollution and Hospital Admission for Cardiovascular and Respiratory Diseases. *JAMA*. 2006. 295:1127–1134. [PubMed: 16522832]
17. Samoli E, Peng R, Ramsay T, et al. Acute Effects of Ambient Particulate Matter on Mortality in Europe and North America: Results from the APHENA Study. *Environ Health Perspect*. 2008. 116: 1480–1486 [PubMed: 19057700]
18. Blasch KW, Kolivosky JE, Heller JM. Environmental Air Sampling Near Burn Pit and Incinerator Operations at Bagram Airfield, Afghanistan. *J Occup Environ Med*. 2016 Aug 58(8S).
19. Weese CB, Abraham JH. Potential health implications associated with particulate matter exposure in deployed settings in southwest Asia. *Inhal Toxicol*. 2009;21:291–296. [PubMed: 19235609]
20. Masiol M, et al. Airborne Dioxins, Furans, and Polycyclic Aromatic Hydrocarbons Exposure to Military Personnel in Iraq. *J Occup Environ Med*. 2016 Aug 58(8).
21. Conlin AM, et al. Birth Outcomes Among Military Personnel After Exposure to Documented Open-Air Burn Pits Before and During Pregnancy. *J Occup Environ Med*. 2012 June 54(6).
22. Department of Veteran Affairs. Report on Data From The Airborne Hazards and Open Burn Pit Registry. 2015 June.
23. Ladich ER, Lewin-Smith MR, Specht CS, et al. A Histopathological Study of Head and Neck Specimens From a Cohort of Persian Gulf War Military Veterans. *Mil Med*. 2002 Oct; 167(10): 864–7. [PubMed: 12392257]
24. De la Hoz RE, Shohet MR, Cohen JM. Occupational Rhinosinusitis and Upper Airway Disease: The World Trade Center Experience. *Curr Allergy Asthma Rep*. 2010 Mar;10(2): 77–83. [PubMed: 20425498]
25. Helfer TM, Canham-Chervak M, Canada S, Mitchener TA. Epidemiology of hearing impairment and noise-induced hearing injury among U.S. military personnel, 2003–2005. *Am J Prev Med*.2010;38:S71–7. [PubMed: 20117602]
26. Rovig GW, Bohnker BK, Page JC. Hearing health risk in a population of aircraft carrier flight deck personnel. *Mil Med*.2004;169:429–32. [PubMed: 15281670]
27. Humes LE, Joellenbeck LM, Durch JS. Noise and Military Service. Implications for Hearing Loss and Tinnitus. Washington, DC: National Academies Press; 2005.
28. US Government Accountability Office. Hearing Loss Prevention: Improvements to DOD Hearing Conservation Programs Could Lead to Better Outcomes. Washington DC: US Government Accountability Office; 2011.
29. Saunders GH, Griest SE. Hearing loss in veterans and the need for hearing loss prevention programs. *Noise Health*.2009;11:14–21. [PubMed: 19265249]
30. Geckle L, Lee R. Soldier perceptions of deployment environmental exposures. Albuquerque, NM: Paper presented at: Force Health Protection Conference; 2004. Aug
31. Wells TS, Seelig AD, Ryan MA, et al. Hearing Loss Associated with US Military Combat Deployment. *Noise Health*. 2015 Jan-Feb 17(74) 34–42. [PubMed: 25599756]
32. Saunders GH, Vachhani JJ, Galvez G, Griest SE. Formative Evaluation of a Multimedia Self-Administered Computerized Hearing Loss Prevention Program. *Int J Audiol* 2015 Apr 54(4) 234–240. [PubMed: 25431117]

33. Banout J, Urban O, Musil V, et al. Agent Orange Footprint Still Visible in Rural Areas of Central Vietnam. *J Environ Public Health*. 2014 Feb.
34. Ngo AD, Taylor R, Roberts CL, Nguyen TV. Association Between Agent Orange and Birth Defects: Systematic Review and Meta-Analysis. *Inter Epidemiol Assoc* 2006 Feb.
35. Chang ET, Boffetta P, Adami HO, et al. A Critical Review of the Epidemiology of Agent Orange/TCDD and Prostate Cancer. *Eur J Epidemiol*. 2014 29(10) 667–723. [PubMed: 25064616]
36. Baumann Kreuziger LM, Tarchand G, Morrison VA, et al. The Impact of Agent Orange Exposure on Presentation and Prognosis of Patients with Chronic Lymphocytic Leukemia. *Leuk Lymphoma*. 2014 Jan 55(1) 63–66. [PubMed: 23573826]
37. Landgren O, Shim YK, Michalek J, et al. Agent Orange Exposure and Monoclonal Gammopathy of Undetermined Significance: A Ranch Hand Veteran Cohort Study. *JAMA Oncol*. 2015 Nov 1(8) 1061–1068. [PubMed: 26335650]
38. Sudhakar D, Clagett CL, Zacher LL. Military Service and Lung Disease. *J Occup Environ Med*. 2014 Oct 56(5S).
39. Lange JL, Schwartz DA, Doebbling BN, et al. Exposures to the Kuwait Oil Fires and Their Association with Asthma and Bronchitis among Gulf War Veterans. *Environmental Health Perspectives*. 2002 Nov 110 (11).
40. Mumford JL, Lewtas J, Williams K, et al. Mutagenicity of Organic Emissions From Unvented Kerosene Heaters in a Chamber Study. *J Toxicol Environ Health*. 1992. 36:151–159.
41. Laslof JC, Knox M, Baldeshwieler JD. Presidential Advisory Committee on Gulf War Veteran's Illnesses: Final Report. 1996 Dec.
42. Franke K, Paustenbach D. Government and Navy Knowledge Regarding Health Hazards of Asbestos: A State of the Science Evaluation (1900 to 1970). *Inhal Toxicol*. 2011; 23: 1–20.
43. Harrington AD, Schmidt MP, Szema AM, et al. The Role of Iraqi Dust in Inducing Lung Injury in United States Soldiers – An Interdisciplinary Study. *Geohealth*. 2017 Jul; 1(5): 237–246. [PubMed: 29085918]
44. Meo SA, Al-Kheraiji MF, Alfaraj ZF, et al. Respiratory and General Health Complaints in Subjects Exposed to Sandstorm at Riyadh, Saudi Arabia. *Pak J Med Sci*. 2013 Apr 29(2): 642–646. [PubMed: 24353595]
45. Krefft SD, Wolff J, Zell-Baran L, et al. Respiratory Diseases in Post-9/11 Military Personnel Following Southwest Asia Deployment. *J Occup Environ Med*. 2020 May 62(5): 337–343. [PubMed: 31977922]
46. Wills JR, Kang C. Chlorine Gas: An Evolving Hazardous Material Threat and Unconventional Weapon. *West J Emerg Med*. 2010; 11:151–156. [PubMed: 20823965]
47. Sudhakar D, Clagett CL, Zacher LL. Military Service and Lung Disease. *J Occup Environ Med*. 2014 Oct 56(10S).
48. Department of the Army Inspector General Special Interest Item Assessment of the Residential Communities Initiatives. 2019 Sept.
49. Jowers K New Association of Privatized Housing Companies Pushing Back on Some Reforms. *Military Times*. 2019 Sept.
50. Wheeler DC, Burstyn I, Vermeulen R, et al. Inside the black box: starting to uncover the underlying decision rules used in a one-by-one expert assessment of occupational exposure in case-control studies. *Occup Environ Med*. 2013. 70:203–210. [PubMed: 23155187]
- 51\*. Patel CJ, Kerr J, Thomas DC, et al. Opportunities and challenges for environmental exposure assessment in population-based studies. *Cancer Epidemiol Biomarkers Prev*. 2017. 26:1370–1380. [PubMed: 28710076] Comment: A comprehensive overview of practices in the military to help identify and study occupational exposures.
52. Krahl PL, Benchoff E, Go YM, et al. Advances in Comprehensive Exposure Assessment: Opportunities for the US Military. *J Occup Environ Med* 2019, Dec 61(12).
53. Bradburne C, Lewis JA. Personalizing Environmental Health: At the Intersection of Precision Medicine and Occupational Health in the Military. *J Occup Environ Med*. 2017 Nov 59(11).





**Figure 1.**  
Burn pit. Balad, Iraq. 9/24/2004. Courtesy photo within public domain. (<https://www.dvidshub.net/image/1741/ burn-baby-burn>) The appearance of U.S. Department of Defense (DoD) visual information does not imply or constitute DoD endorsement.

**Table 1:**

Summary of potential occupational exposures in military personnel.

<b>Exposure</b>	<b>Personnel affected</b>	<b>Potential Risks and symptoms</b>
Burn pits	Veterans of Iraqi War and Operation Enduring Freedom	Chronic lung disease/Chronic sinusitis/Birth defects and preterm delivery
Noise pollution	Most service members	Hearing loss/Tinnitus
Agent Orange	Veterans of Vietnam War	Birth defects/cancers
Asbestos	Navy veterans up until the 1980's	Lung disease/mesothelioma
Oil fires	Veterans of the Gulf War	Asthma exacerbations and acute respiratory symptoms. Chronic symptoms unlikely
Sandstorms	Most Veterans deployed to the Middle East	Chronic lung disease/chronic rhinosinusitis
Chemical warfare	Certain veterans exposed to chlorine during Iraqi War	Acute respiratory distress/Possible chronic lung damage

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