



Particulate Matter (PM) Air Pollution Exposures During Military Deployments

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Background. Particulate matter (PM) air pollutants are a complex mixture of extremely small solid particles and liquid droplets in the air. When breathed in, these particles can reach deep into the lungs and cause various health effects. There are generally two size ranges of particles in the air that are of health concern. These include: 1) particles with a diameter less than or equal to 10 microns (PM_{10}), and 2) even smaller particles [less than a diameter of 2.5 microns ($PM_{2.5}$)]. The smaller particles ($PM_{2.5}$) have recently become an increasing concern since



medical research shows that particles of this size are most likely responsible for the harmful health effects attributed to PM. Many variables influence the nature and probability of health outcomes. The key variables are the size-fraction and chemical-make up of the PM, the concentration levels, the duration of exposures, and various human factors to include age, health status and existing medical conditions, and genetics. These variables combined with scientific data gaps limit the medical community's ability to estimate health impacts to relatively healthy troops, especially as most studies have been on older or less healthy groups.

Sources of Particulate Matter Air Pollution

PM emissions are from natural and manmade sources. These sources include windblown dusts, fires, construction activities, factories, power plants, incinerators, and automobiles. In the U.S., the European Union, and certain other industrialized regions of the world, fossil fuel combustion and vehicle emissions are the primary sources of these pollutants. In some deployment regions, notably Southwest Asia, the PM levels are higher and the sources of PM are different:

- Primary sources are short-term dust storms and dust from motor vehicle disturbance of the desert floor.
- Dust storm levels often exceed typical levels in the U.S. (as much as 10 times higher than at U.S. sites).
- Distribution of particle size and $PM_{10/2.5}$ ratio differs with location, though typically the PM_{10} is higher.
- Emissions from local industries (e.g., brick factories) near base camps and military operations (e.g., burn pits, vehicles) may increase localized concentration of $PM_{2.5}$ and other potentially toxic air pollutants.

Health Effects to Deployed Soldiers and Current Military Exposure Guidelines (MEGs)

Most studies relate PM exposure data to respiratory and cardiopulmonary health effects in specific susceptible general population subgroups to include young children, the elderly, and especially those with existing asthma or cardiopulmonary disease. In addition, studies of PM-related health effects have been based/conducted primarily in U.S. and Europe urban settings where the PM particle size and composition tends to be substantially different from that in deployment settings in Southwest Asia. PM from these deployment settings is generally less influenced by combustion products, acid aerosols, and other potentially toxic pollutant PM components that come from the industrial-sources and vehicle emissions in highly urbanized areas. As a result, direct use of the available data to estimate health effects to troops in Southwest Asia has been problematic. Several ongoing studies will increase our knowledge regarding the potential relationship between PM exposures to deployed troops and health effects/outcomes. In the interim, USAPHC recommends the use of the Military Exposure Guidelines (MEGs) described in Tables 1 and 2 below to assess the severity of potential short term (acute) and long term (chronic) effects. These MEGs are based on criteria from the U.S. Environmental Protection Agency (EPA) National Ambient Air Quality Standards (NAAQS) and the EPA Air Quality Index (AQI) reporting system (adjusted to reflect the generally health military population). The MEGs are based on professional judgment reflecting the current consensus opinion of USAPHC subject matter experts. Due to the substantial scientific

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uncertainty in estimating acute and especially chronic health outcomes amongst relatively healthy troops to exposures involving very unique PM compositions, these MEGs are protective estimates for which there is relatively low confidence. This should be reflected in PM exposure health effects risk estimates.

Table 1. Short-Term (24-hour) Particulate Matter Air-MEGs*

Hazard Severity	PM _{2.5}	PM ₁₀	Description of Military Health and Operational Effects
Critical	500 µg/m ³	600 µg/m ³	Above these levels, most if not all personnel are expected to experience very notable eye, nose, and throat irritation and respiratory effects. Visual acuity is impaired, as is overall aerobic capacity. Significant aerobic activity will increase risk. Some personnel will not be able to perform assigned duties. Lost duty days are expected at this concentration and potentially more as concentrations increase. Those with a history of asthma or cardiovascular disease will experience more severe symptoms.* Conditions may also result in adverse, non-health related materiel/logistical impacts (e.g., vehicles, equipment).
Marginal	250 µg/m ³	420 µg/m ³	Above these levels up to the Critical level, many personnel are expected to experience notable eye, nose, and throat irritation and some respiratory effects. Some lost duty days are expected. Significant aerobic activity will increase risk. Those with a history of asthma or cardiovascular disease are expected to experience increased symptoms.**
Negligible	65 µg/m ³	250 µg/m ³	Above these levels up to the Marginal level, a few personnel may experience notable mild eye, nose, or throat irritation; most personnel will experience only mild effects. Pre-existing health conditions (e.g., asthma, or cardiovascular diseases) may be exacerbated.*

* MEG values are low-confidence effects range estimates considered protective bounds of the hazard severity concentration ranges

** A diagnosis of some pulmonary or cardiovascular disease may prevent deployment but individuals may have mild or undiagnosed conditions. A small percentage of deployed personnel fall into this sensitive group.

Table 2. Long-Term (1-year) Particulate Matter Air-MEGs*

Hazard Severity	PM _{2.5}	PM ₁₀	Description of Military Health and Operational Effects
Marginal	65 µg/m ³	**Not defined	With repeated exposures above this level it is increasingly plausible that some personnel may be at increased risk for developing chronic health conditions such as reduced lung function or exacerbated chronic bronchitis, chronic obstructive pulmonary disease (COPD), asthma, atherosclerosis, or other cardiopulmonary diseases. Those with a history of asthma or cardiopulmonary disease are considered to be at more notable risk.
Negligible	15 µg/m ³	**Not defined	With repeated exposures above this level up to the Marginal level, it is considered possible that a small percentage of susceptible personnel <i>may</i> be at increased risk for developing chronic conditions such as reduced lung function or exacerbated chronic bronchitis, COPD, asthma, atherosclerosis, or other cardiopulmonary diseases. Those with a history of asthma or cardiopulmonary disease are considered to be at more notable risk. Exposures below this level are not expected to result in chronic health conditions in generally healthy troops.

* MEG values are low-confidence effects range estimates considered protective bounds of the hazard severity concentration ranges

** No long term health effects can be estimated from data – the EPA has retracted its long-term standard (NAAQS) for PM₁₀.

Preventive Medicine and Surveillance Recommendations.

While specific individual assessments cannot be determined given current data gaps, the USAPHC is currently documenting/archiving site-specific PM exposure data for future research and medical surveillance purposes. Other than the sampling and documentation of the population-based exposure data, there are limited preventive measures to mitigate PM exposures. The primary measure is to limit outdoor activity during periods of high PM levels; especially limit physical exertion since higher breathing rates increase the amount of inhaled PM.

Minimize PM from outside sources by shutting windows, doors, and closing tent flaps. Some limited exposure may be mitigated through the use of cravats/handkerchiefs, though this is not likely to provide substantial reduction, particularly for PM_{2.5} exposures. If continued exposures to very high levels cannot be avoided, use of N-95 filtering facepieces may be considered but requires a respiratory protection program, appropriate fit testing and handling of masks, and may not be feasible for extended periods due to mask clogging, discomfort, and interference with operations.

