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OCCUPATIONAL PROTECTION OF SEARCH AND RESCUE PERSONNEL DURING EARTHQUAKE RESPONSE: AN URGENT CALL FOR INTEGRATED RESPIRATORY HEALTH SURVEILLANCE

PROTECCIÓN LABORAL DEL PERSONAL DE BÚSQUEDA Y RESCATE DURANTE LA RESPUESTA A TERREMOTOS: UN LLAMAMIENTO URGENTE A LA VIGILANCIA INTEGRADA DE LA SALUD RESPIRATORIA

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Resumen

El personal de búsqueda y rescate (SAR) desplegado en operaciones de respuesta a terremotos está expuesto a riesgos aéreos complejos, como sílice cristalina respirable, fibras de amianto, partículas derivadas de la combustión y material particulado fino y ultrafino. La evidencia de grandes desastres, especialmente el colapso del World Trade Center y los recientes terremotos en Asia y Oriente Medio, demuestra tanto efectos respiratorios agudos como enfermedades crónicas de las vías respiratorias a largo plazo entre los rescatistas. A pesar de la solidez de esta evidencia, las medidas de protección de la salud ocupacional siguen implementándose de forma inconsistente en los entornos de respuesta a desastres en todo el mundo. La protección respiratoria se retrasa con frecuencia o se aplica de forma inadecuada durante las fases más peligrosas del despliegue, cuando la intensidad de la exposición es mayor. Este editorial destaca la brecha persistente entre la evidencia científica y la práctica operativa y aboga por la integración obligatoria de la protección respiratoria, la vigilancia estructurada de la salud ocupacional y el seguimiento a largo plazo del personal expuesto. Se propone un Marco de Protección del Rescatista simplificado pero integrado para guiar la prevención en las fases de preparación, despliegue y post-despliegue.

Palabras claves: salud ocupacional, salud respiratoria, rescatistas, prevención.

Abstract

Search and rescue (SAR) personnel deployed in earthquake response operations are exposed to complex airborne hazards, including respirable crystalline silica, asbestos fibers, combustion-derived particles, and fine and ultrafine particulate matter. Evidence from major disasters—most notably the World Trade Center collapse and recent earthquakes in Asia and the Middle East—demonstrates both acute respiratory effects and long-term chronic airway disease among responders. Despite the robustness of this evidence, occupational health protection measures remain inconsistently implemented in disaster response settings worldwide. Respiratory protection is frequently delayed or inadequately applied during the most hazardous phases of deployment, when exposure intensity is highest. This editorial highlights the persistent gap between scientific evidence and operational practice and argues for the mandatory integration of respiratory protection, structured occupational health surveillance, and long-term follow-up of exposed personnel. A simplified but integrated Rescuer Protection Framework is proposed to guide prevention across preparedness, deployment, and post-deployment phases.

Keywords: occupational health, respiratory health, rescuers, prevention.

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1. Introduction

Earthquake response operations represent one of the most demanding and hazardous environments in occupational and disaster medicine. Search and rescue personnel operate under extreme conditions characterized by structural collapse, unstable debris fields, limited visibility, high physical workload, and intense psychological stress. Within this context, airborne exposure to hazardous particulate matter constitutes a major yet still insufficiently controlled occupational risk.

The collapse of buildings generates a highly heterogeneous aerosol composed of respirable crystalline silica, asbestos fibers, cement dust, heavy metals, and combustion-related by-products, including fine and ultrafine particulate matter capable of reaching the distal airways and alveolar spaces. The toxicological complexity of this mixture is compounded by the absence of environmental control in the early phases of disaster response.

The World Trade Center disaster in 2001 marked a pivotal moment in the understanding of disaster-related occupational respiratory disease. Long-term cohort studies of exposed responders have demonstrated persistent respiratory symptoms, accelerated decline in lung function, and increased prevalence of asthma-like disease. Importantly, these health effects have persisted for decades, underscoring that acute disaster exposure may translate into chronic, progressive respiratory morbidity.

Subsequent earthquakes in Japan (2011), Nepal (2015), Taiwan (2016), and Türkiye–Syria (2023) have reinforced these findings, consistently reporting increased respiratory symptom burden among deployed SAR personnel. Although study designs vary, the direction of evidence is remarkably consistent: disaster dust exposure is not a transient irritant phenomenon but a determinant of long-term respiratory health outcomes.

2. Development

Respiratory hazards in earthquake environments

Airborne dust generated in earthquake settings is not a single pollutant but a complex mixture of fibrogenic, carcinogenic, and irritant agents. Of particular concern is respirable crystalline silica, a well-established cause of silicosis, chronic obstructive pulmonary disease, and lung cancer. In disaster contexts, silica exposure occurs in unpredictable, high-intensity bursts, often without adequate respiratory protection or environmental monitoring.

In addition, asbestos fibers may be released from older building materials during structural collapse, adding a carcinogenic component to the exposure profile. When combined with combustion products, metal particulates, and ultrafine particles, the resulting inhalational exposure becomes a multidimensional respiratory hazard with both acute and chronic implications.

Clinically, SAR personnel may experience acute respiratory irritation, cough, dyspnea, and bronchial hyperreactivity during or shortly after deployment. More concerning, however, is the growing body of evidence indicating long-term respiratory sequelae, including persistent airway inflammation, asthma-like syndromes, and fixed airflow obstruction.

Psychological and systemic burden

The occupational burden of disaster response extends beyond the respiratory system. SAR personnel are repeatedly exposed to traumatic scenes, including mass casualties, severe injuries, and destroyed urban environments. This exposure is associated with a high prevalence of acute stress reactions, anxiety, depression, burnout, and post-traumatic stress disorder (PTSD).

Importantly, psychological and physiological stressors are not independent. Increasing evidence suggests that systemic stress responses may amplify inflammatory pathways, potentially exacerbating respiratory vulnerability and

contributing to poorer long-term outcomes.

The evidence–practice gap

Despite decades of accumulated evidence, occupational protection for SAR personnel remains inconsistently implemented. In many disaster responses, respiratory protection is either delayed, insufficiently fitted, or unavailable during the initial and most hazardous phases of deployment.

This disconnect reflects a structural issue in disaster preparedness systems, where operational urgency often supersedes occupational health considerations. Yet the scientific literature clearly indicates that the earliest exposure period is frequently the most damaging in terms of long-term respiratory outcomes.

The absence of standardized global protocols for respiratory protection and health surveillance in disaster response represents a critical gap in international occupational health policy.

Towards an integrated protection model

To address this gap, an integrated Rescuer Protection Framework (RPF) is proposed. This model organizes preventive strategies across five interdependent domains:

1. Environmental control, including dust suppression and exposure zoning
2. Respiratory protection, with mandatory fit-tested N95/FFP2 or higher respirators
3. Occupational health surveillance, including pre-deployment screening and post-deployment monitoring
4. Psychological protection, incorporating structured mental health support systems
5. Long-term follow-up, ensuring detection of delayed respiratory and psychological outcomes

This framework aims to reposition occupational health as an essential structural component of disaster response systems rather than an ancillary consideration.

Policy implications

The available evidence strongly supports the need for a paradigm

shift in disaster response policy. Respiratory protection for SAR personnel should not be considered optional or context-dependent, but rather a mandatory operational standard.

International agencies, including WHO, INSARAG, and national civil protection systems, should incorporate standardized occupational health protocols into disaster preparedness and deployment frameworks. These should include mandatory respiratory protection, exposure documentation, and longitudinal health surveillance.

Without such measures, the global disaster response system will continue to generate preventable occupational disease among those who are essential to saving lives in the acute phase of emergencies.

3. Conclusions

Search and rescue personnel occupy a critical position at the front line of disaster response, yet remain insufficiently protected from well-documented occupational hazards. Evidence from multiple disaster contexts demonstrates that respiratory exposure during earthquake response operations is associated with both acute and long-term health consequences.

Closing the gap between scientific evidence and operational practice is an urgent priority. Integrating respiratory protection, occupational surveillance, and long-term follow-up into standard disaster response protocols is not only a scientific necessity but also an ethical imperative.

Protecting those who risk their lives to save others must become a foundational principle of modern disaster medicine.

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