

# The effects of volcanoes on health: preparedness in Mexico

Inés Luis Zeballos<sup>a</sup>, Roberto Meli<sup>b</sup>, Arturo Vilchis<sup>c</sup> & Leonel Barrios<sup>d</sup>

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## Introduction

The enormous destructive power of volcanic eruptions has held a fascination for humanity throughout history. The story of Mount Vesuvius, with the disappearance of Pompeii and other cities in 79 AD, is classic. In modern times, there have been some very deadly volcanoes: Tambora in Indonesia took the lives of 92 000 people in 1815; Krakatoa in that same country produced 36 417 victims in 1883; Mount Pelée in Martinique caused the deaths of 29 025 people in 1902; and in 1985, the Nevado del Ruiz in Colombia caused the deaths of 23 000 people (1).

The destructive power of volcanoes originates in phenomena such as pyroclastic flows, whose burning fragments can attain speeds of 150 km/hour and temperatures ranging from 900 °C to 1200 °C, showers of volcanic ash which can affect a radius of 80 km or more; lava flows that destroy all vegetation in their path; lahars or mudstreams produced by the thawing of the volcanic cone, the mixture of ash, rain or water from lakes; volcanic gases that, like carbon dioxide, are denser than air and can cause death by asphyxiation; and the earthquakes and tsunamis that often accompany volcanic eruptions. It is estimated that more than 200 000 people may have lost their lives in recent years to volcanic eruptions (2).

The health effects on populations exposed to volcanic eruptions vary and can usually be classified as either physical or psychological:

**Physical effects:** Trauma and wounds from pyroclastic material; second- and third-degree burns, death by suffocation, acute irritation of the respiratory tract caused by ash, or exacerbation of prior respiratory disease caused by inhaled particles such as silica; respiratory tract and lung burns caused by inhalation of hot steam; conjunctivitis or corneal abrasion; intoxication by gases such as carbon dioxide, hydrogen sulfide, sulfur dioxide, hydrogen fluoride, carbon monoxide, and radon, gastro-

enteritis, skin irritation from acid water, and drowning in sudden volcanic mudflows (1-3).

**Psychological effects:** Depression, anxiety, nightmares, psychomotor disorders, irritability, insomnia, confusion, neurosis and stress (3).

For example, during the El Ruiz Volcano eruption which took place in Colombia in November 1985, the lahars (mixture of melted snow, rocks and mud) falling from above 5 432 m buried 23 000 people. The 4 main categories of injuries among the 834 survivors attended in the neighboring hospitals were 578 lacerations (69.3%), 343 penetrating injuries (41.1%), 312 fractures (37.4%) and 272 eye injuries (32.3%) (7). Many survivors had more than one kind of injury.

The main causes of death were suffocation due to mud aspiration, multiple trauma, hypovolemic shock and gangrene complications (7).

During the eruption of Mount Saint Helens in Washington State in 1981, asphyxia from ash inhalation was the main cause of death in 18 of 23 cases, while 4 deaths were due to burns and 1 to head injuries. A hospital surveillance system detected increases in asthma and bronchitis cases in communities with heavy ash fall after eruptions on 18 and 25 May and on 12 June (8). Crystalline-free silica which may be contained in ash fall is a cause of concern for potential pneumoconiosis in exposed occupational groups (8).

A correlation between exposure to ash emitted by the Popocatepetl and acute respiratory infections was demonstrated during the ash emission in December 1994 (9). Exposure to volcanic ash may affect immunological parameters as explained during a study of occupational exposure in loggers, after the Mount Saint Helens eruption in 1981 (10).

Volcanic gases can be asphyxiants or irritants. A build-up of asphyxiant gases to lethal concentrations like carbon dioxide (CO<sub>2</sub>), is likely only in the vicinity of the volcanic crater or fissures, while irritant gases such as sulfur dioxide (SO<sub>2</sub>) may exert their effects in much lower concentrations for many kilometers downwind, and cause acute irritation to the respiratory tract or produce asthma in susceptible persons (1).

## Popocatepetl and its activity

Mexico has 13 volcanoes that have demonstrated some kind of activity in recorded history. Fig. 1

<sup>a</sup> Representative of Mexico to the Pan American Health Organization and the World Health Organization.

<sup>b</sup> Director General of the National Disaster Prevention Centre, Office of Civil Defense, Secretariat of the Interior of Mexico.

<sup>c</sup> Director of Sectoral Coordination, Office of Civil Defense, Secretariat of the Interior of Mexico.

<sup>d</sup> PAHO/WHO Consultant in Health Services in Mexico.