

## **Impact of earthquakes and their secondary environmental effects on public health**

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Earthquakes are among the most impressive geological processes with destructive effects on humans, nature and infrastructures. Secondary earthquake environmental effects (EEE) are induced by the ground shaking and are classified into ground cracks, slope movements, dust clouds, liquefactions, hydrological anomalies, tsunamis, trees shaking and jumping stones. Infectious diseases (ID) emerging during the post-earthquake period are considered as secondary earthquake effects on public health.

This study involved an extensive and systematic literature review of 121 research publications related to the public health impact of 28 earthquakes from 1980 to 2015 with moment magnitude ( $M_w$ ) from 6.1 to 9.2 and their secondary EEE including landslides, liquefaction and tsunamis generated in various tectonic environments (extensional, transform, compressional) around the world (21 events in Asia, 5 in America and one each in Oceania and Europe). The inclusion criteria were the literature type comprising journal articles and official reports, the natural disaster type including earthquakes and their secondary EEE (landslides, liquefaction, tsunamis), the population type including humans and the outcome measures characterized by disease incidence increase.

The potential post-earthquake ID are classified into 14 groups including respiratory (detected after 15 of 28 earthquakes, 53.57%), water-borne (15, 53.57%), skin (8, 28.57%), vector-borne (8, 28.57%) wound-related (6, 21.43%), blood-borne (4, 14.29%), pulmonary (4, 14.29%), fecal-oral (3, 10.71%), food-borne (3, 10.71%), fungal (3, 10.71%), parasitic (3, 10.71%), eye (1, 3.57%), mite-borne (1, 3.57%) and soil-borne (1, 3.57%) infections. Based on age and genre data available for 15 earthquakes, the most vulnerable population groups are males, young children (age  $\leq 10$  years) and adults (age  $\geq 65$  years). Cholera, pneumonia and tetanus are the deadliest post-earthquake ID. The risk factors leading not only to disease emergence but also to disease incidence increase include (1) damage to infrastructures and health care systems that remained unfixed for a long time in the critical post-earthquake period, (2) aggravating weather conditions comprising immense and dramatic temperature changes, (3) prolonged physical exposure to large dust clouds generated by landslides and aspiration of contaminated tsunami water, (4) unfavorable conditions in overcrowded emergency shelters, (5) increased exposure to disease vectors population, (6) the weak immune system of elders, chronically ill individual and young children, (7) large percentage of illiteracy and population living below the national poverty line (insufficient personal hygiene), (8) poor education and training on disease prevention, (9) sanitary deficiencies, (10) lack of screening for blood-borne diseases before emergency surgeries, blood transfusions and intravascular drug use, (11) use of unsterilized medical equipment, (12) insufficient or low vaccination coverage and (13) close contact with the affected local population. In conclusion, our study referred to potential ID following strong, major and great earthquakes and their secondary EEE from 1980 to 2015. The establishment of a strong disaster preparedness plan following international guidelines and comprising adequate environmental and infrastructure planning and resilience of health facilities is fundamental for the enhancement of surveillance systems, the early detection of the emergence and spread of ID and their successful management.