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The respiratory hazard of concomitant inhalation of volcanic ash and anthropogenic pollution: an in vitro study

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Human exposure to inhalable volcanic ash particles is a health concern, as it can potentially contribute towards adverse respiratory health effects, especially when considering communities living in urban areas already exposed to heightened air pollution. A prime example of this is Mexico City, which sits just 70 km from the frequently-erupting Popocatepetl volcano. Although there is substantial information on the physicochemical properties of volcanic ash that may influence its biological reactivity, knowledge as to how external factors, such as air pollution, contribute to and augment the potential reactivity is limited. The aim of this study was, therefore, to gain a first understanding of the biological impact of the respirable fraction of volcanic ash when exposed with diesel exhaust particles (DEP) in vitro. A sophisticated 3D triple cell co-culture model mimicking the human epithelial tissue barrier was exposed to DEP [0.02 mg/mL] and then exposed to either a single or repeated dose of dry respirable volcanic ash (0.26 ± 0.09 or 0.89 ± 0.29 µg/cm2, respectively) from the Soufrière Hills volcano, Montserrat for a period of 24 hours. Cultures were subsequently assessed for adverse biological endpoints including cytotoxicity, oxidative stress and (pro)-inflammatory responses. Although there was no evidence of cytotoxicity or oxidative stress, the results indicated that the combination of DEP and respirable volcanic ash at sub-lethal concentrations can promote a significant (pro-)inflammatory response in vitro. This finding strongly suggests that the combined exposure to volcanic and urban particulate matter should be further investigated in order to deduce the specific human health hazard. Future work will aim to investigate if this (pro-)inflammatory effect is maintained for ash exposure concurrent with complete vehicle exhaust, containing both particulate and gaseous components.