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Polystyrene nanoplastics mediate ROS production and apoptosis in A549 cell line

Cristina Milillo

*C Milillo^{1,5}, M Pesce², A Patruno², E Aruffo^{3,5}, P Di Carlo^{3,5},
V di Giacomo⁴, L Marinelli⁴, G Miscia⁵, M Reale³, P Ballerini^{3,5}*

¹Department of Psychological, Health, and Territorial Sciences, CHIETI, Italy

²Department of Medicine and Aging Sciences, CHIETI, Italy

³Department of Innovative Technologies in Medicine and Dentistry, CHIETI, Italy

⁴Department of Pharmacy, CHIETI, Italy

⁵Center for Advanced Studies and Technology, CHIETI, Italy

Contact: cristina.milillo@unich.it

Background:

The ubiquity of single-use plastics has led to a global plastic pollution challenge with significant environmental and health consequences. Physical, chemical, and biological processes such as erosion, photo-oxidation, and biodegradation cause the plastic to erode, eventually forming debris in the size range from micro-plastics (MP) to nano-plastics (NP). Although NP has been extensively studied as a pollutant in marine and water environments, its potential detrimental effects, when present in the atmosphere, are still poorly investigated. In this study, we used polystyrene NP (PS-NP) in evaluating their potential toxic effects on the A549 cell line as a representative in vitro model of human lung epithelial cells.

Methods:

The A549 cells were treated with concentrations of PS-NP (800 nm diameter) in the range of 10-500 mg/ml and for different time intervals up to 96 h. Cell viability, oxidative stress and senescence, were evaluated by commercially available kits, apoptosis was assessed by cytofluorimetric assay. Their capability to cross physiological barriers was assessed by Parallel Artificial Membrane Permeability Assay (PAMPA) and Caco-2 cell monolayer.

Results:

PS-NP reduced cell vitality after 72 h of treatment at all the concentrations used. They also induced a marked increase in reactive oxygen species (ROS) production in a dose-dependent manner. Accordingly, PS-NP upregulated ROS-related genes evaluated by qPCR. PS-NP induced apoptosis after 96 h of treatment, whereas they were unable to induce senescence at the size and concentrations used. As expected, PAMPA results revealed no passive diffusion of PS-NP after 3 and 18 h, caco-2 assay excluded additional permeation mechanisms within 24h.

Conclusions:

This study showed that atmospheric PS-NPs can represent a hazard to human lung health once inhaled. They cannot be degraded; thus they can be continuously accumulated and able to worsen pre-existing disease states or increase sensitivity to them.

Key messages:

- The results indicated a significant effect of polystyrene nanoplastics on airway cell viability, ROS formation, and apoptosis.
- The study helps define the harmful effects of exposure to airborne polystyrene nanoplastics on human health at the respiratory system level.