

Abstract Submission No.: A-1178

Polystyrene Microplastic-Induced Extracellular Vesicles Cause Endoplasmic Reticulum Stress and Reactive Oxygen Species Production in the Kidneys

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Objectives : Plastic waste accumulation and its degradation into microplastics (MPs) and nanoplastics pose environmental concerns. Extracellular vesicles (EVs) are associated with metabolic reprogramming and mitochondrial dysfunction in various kidney diseases. The current study evaluated how polystyrene MPs (PS-MPs) affected tubular cells and fibroblasts.

Methods : We evaluated PS-MPs' effects on bidirectional interactions between diverse cell types and their microenvironment in kidneys. The effects of the conditioned medium of PS-MPs on endoplasmic reticulum (ER) stress, autophagy, inflammation and reactive oxygen species (ROS) were examined in tubular epithelial cells or fibroblasts.

Results : PS-MPs increased EV production in human tubular cells and caused ER stress-related proteins without inducing inflammation-related proteins in human tubular cells. The uptake of PS-MPs and incubation with the conditioned medium of PS-MPs induced ROS production and ER stress-related proteins in fibroblast cells. The fibroblast cells treated with the conditioned medium of PS-MPs also increased the expression of fibrosis-related proteins. Our findings suggested that the expression of EV-related markers increased in tubular cells via Beclin 1 after PS-MP treatment. In addition, PS-MPs induced ROS production in vitro and in vivo. We found that PS-MPs altered the expression of EV markers in urine and CD63 expression was also increased in vitro and in vivo after PS-MP treatment.

Conclusions : PS-MP-induced EVs lead to ER stress-related proteins, ROS production and fibrosis-related proteins in tubular cells and fibroblasts.