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Pre- and Postnatal Chronic Exposure to Airborne Particulate Matter: Focus on Renal Fibrogenesis and the Role of Vitamin D Supplementation

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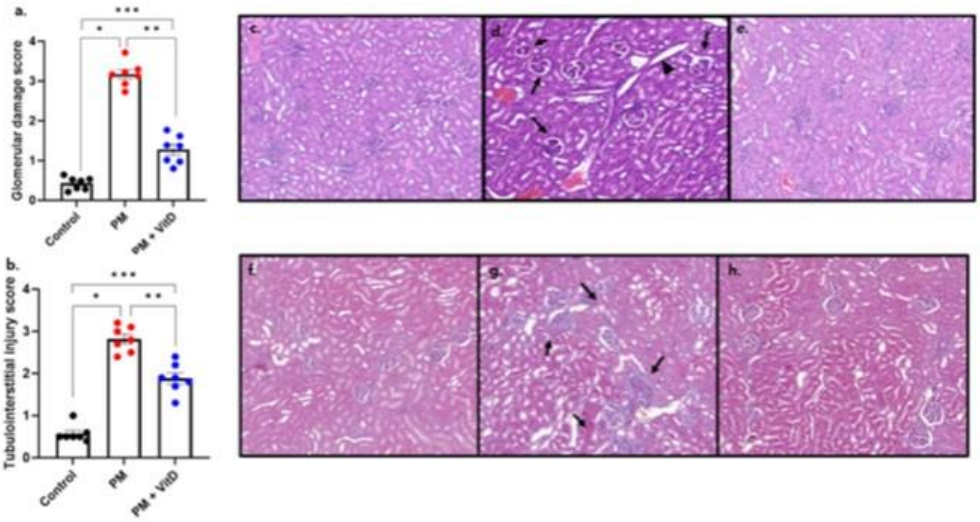
Objectives : Long-term exposure to fine particulate matter ($PM_{2.5}$) is the important risk factor for global premature mortality. This study aimed to investigate whether pre- and postnatal chronic $PM_{2.5}$ exposure can induce renal fibrosis later in life. We also measured the effects of vitamin D supplementation on the underlying molecular pathways involved in renal damage induced by long-term $PM_{2.5}$ exposure.
Methods : Pregnant Sprague–Dawley rats were randomly assigned to three groups (N=3/group); normal saline (NS, controls), $PM_{2.5}$, and $PM_{2.5}$ with vitamin D during gestation and lactation. Their respective male rat offspring were subsequently exposed to NS, $PM_{2.5}$, or $PM_{2.5}$ with vitamin D during 3 to 8 weeks after birth (n=5/group). Their kidneys were taken for morphometric, immunohistochemical, and Western blot studies on postnatal day 56.
Results : The adult offspring rats exposed to $PM_{2.5}$ exhibited lower body weight and higher glomerular and tubular injury scores, compared to control rats; while these alterations were abolished by vitamin D intake. Persistent $PM_{2.5}$ exposure elevated the expression of intrarenal renin and transforming growth factor-ß1, compared to control rats. Activation of mesenchymal cell marker proteins such as α-smooth muscle actin and vimentin was detected in the $PM_{2.5}$-exposed kidneys although the expression of E-cadherin, a representative epithelial marker, was not repressed by $PM_{2.5}$ exposure. Long-term vitamin D supplementation reversed the upregulation of renin, transforming growth factor-ß1, and α-smooth muscle actin in adult rat offspring kidneys. The expression of Wnt-4 and ß-catenin was not changed by the exposure to $PM_{2.5}$ with or without vitamin D.
Conclusions : Pre-and postnatal long-term exposure to airborne $PM_{2.5}$ can activate intrarenal renin and fibrogenic molecules later in life. Long-term vitamin D supplementation may possibly reverse $PM_{2.5}$-induced fibrogenic renal changes in adulthood.

Fig 1.jpg


a.
Glomerular damage score
Control
PM
PM + VitD
b.
Tubulointerstitial injury score
Control
PM
PM + VitD
c.
d.
e.
f.
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