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Maternal Exposure to Fine Particulate Matter Impairs Renal Vascular Homeostasis in Adult Male Rat Offspring: Impact of Maternal Vitamin D Supplementation

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Objectives : Maternal exposure to fine particulate matter (PM_{2.5}) during pregnancy has been linked to adverse postnatal health outcomes. In this study, we aimed to investigate the long term effect of maternal exposure to PM_{2.5} during gestation and lactation on the vascular homeostasis in adult rat offspring kidney. We also evaluated the effect of maternal vitamin D supplementation during fetal rat nephrogenesis on PM_{2.5}-induced renal vascular disturbance in adult rat offspring.

Methods : Nine pregnant Sprague–Dawley rats received oral administration of normal saline, PM_{2.5}, or PM_{2.5} with vitamin D (cholecalciferol 1,000 IU/kg) during gestation and lactation. Kidneys of male offspring (n = 5 for each group) were taken for morphometric, immunohistochemical, and Western blot studies on postnatal day 56. Angiogenic and anti-angiogenic factors were evaluated with the investigation of renal capillary rarefaction.

Results : The adult offspring rats exposed to maternal PM_{2.5} exhibited lower body weight and higher glomerular and tubular injury scores, compared to control rats. Maternal vitamin D supplementation with PM_{2.5} exposure attenuated these changes. Maternal PM_{2.5} exposure group presented lower vitamin D receptor and klotho expression and higher renin, angiotensin converting enzyme and cytochrome P450 27B1 expression in their kidneys than the control group. Intrarenal VEGF increased while VEGF receptor 2, angiopoietin-1, and Tie-2 protein expression decreased in the offspring rats exposed to maternal PM_{2.5}. JG12-positive glomerular and peritubular capillary staining was reduced in the PM_{2.5} exposure group. Maternal vitamin D administration with PM_{2.5} restored intrarenal VEGF receptor 2 and angiopoietin-1 expression, together with the increase of JG12 expression in the capillary endothelium of adult offspring kidneys. Angiotensin converting enzyme activity was reduced by maternal vitamin D intake with PM_{2.5} exposure.

Conclusions : Maternal PM_{2.5} exposure during nephrogenesis may lead to the impairment of renal vascular homeostasis in their adult offspring, and maternal vitamin D supplementation could attenuate PM_{2.5}-induced renal vascular damage in the long-term.

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