Association between PM2.5 exposure by inhalation and brain damages of Alzheimer’s disease in transgenic mice

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ABSTRACT

Background: Fine particulate matter (PM2.5) exposure increases the risk of neurological disorders. However, the relevance between PM2.5 and Alzheimer’s disease (AD) needs to be identified and the effect of PM2.5 exposure on the brain in AD mice remains unclear.

Objective: To assess the effects of PM2.5 exposure on AD and investigate the brain damage in AD transgenic mice exposed to PM2.5.

Methods: We searched articles from the database of PubMed for meta-analyses on the association between PM2.5 exposure and AD. Further, using a novel real-world whole-body inhalation exposure system, wild type (WT) and APP/PS1 transgenic mice (AD mice) were respectively exposed to filtered air (FA) or ambient PM2.5 for 8 weeks in Taiyuan, China. The pathological and ultrastructural changes and levels of Aβ-42, TNF-α, and IL-6 in brains in FA-WT mice, FA-AD mice, FA-PM2.5 mice, and PM2.5-AD mice were measured.

Results: Long-term PM2.5 exposure had the association with increased risks of dementia and AD by OR of 1.16 (95% CI 1.07–1.26) and 3.26 (95% CI 0.84–12.74) via meta-analysis. Both lightly- and heavily polluted countries showed such increased risks. In the open field test, the PM2.5-AD mice
showed more significant degenerative symptoms of AD by the behavioral change in movement. Hematoxylin-eosin staining results showed that noticeable histopathological injury such as structural disorder, hyperemia, and sporadic inflammatory cell infiltration in the brain of PM$_{2.5}$-AD mice, and transmission electron microscope results displayed that serious damage in the brain in PM$_{2.5}$-AD mice, which maintained disorder of cristae and vacuolation of mitochondria, synaptic abnormalities, and loose myelin sheaths. Aβ-42, TNF-α and IL-6 levels in brains of PM$_{2.5}$-AD mice had raised more strongly than that of FA-WT or FA-AD mice.

**Conclusion:** This study indicated a strong association between PM$_{2.5}$ exposure and AD risks. PM$_{2.5}$ significantly aggravated the severity of neuronal pathomorphological changes and inflammation in AD mice when Aβ-42 levels in the brain were visibly increased.

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