Association between Chemical Components of Airborne Particulate Matter and Incidence of Allergy and Lifestyle-related Disease in Childhood

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[Abstract]

Key Words: Fine particulate matter, Chemical components, Children, Health effects, Allergy, Lifestyle-related diseases, Exposure estimating model, Machine learning

Background: Prenatal and postnatal exposures to air pollutants have been associated with adverse outcomes in childhood. This study aimed to investigate the associations between exposures to chemical components of fine particulate matter ($PM_{2.5}$) and allergic and lifestyle-related diseases in childhood.

Methods: The study involved 2,058 children, aged 7-8 years, who lived in Amagasaki, Japan, and participated in the health examination of the Japan Environment and Children's Study, between 2019 and 2021. The examination included anthropometrics, blood pressure check, and blood sampling for the measurement of serum total and specific IgE, HbA1c, and lipids. Respiratory and allergic symptoms, past and family histories, living environments, and socioeconomic factors were assessed by a questionnaire. Exposures to $PM_{2.5}$ and its major chemical components (sulfate, nitrate, ammonium, elemental carbon, and organic carbon) were estimated for each child from pregnancy to 6 years, using a prediction model developed from a random forest algorithm. Logistic regression models were used to evaluate the associations between the exposure estimates to air pollutants and health outcomes, after adjusting for confounding factors.

Results: An increased nitrate concentration during pregnancy was significantly associated with wheezing at 7-8 years (odds ratio: 1.68, 95% confidence interval: 1.08-2.63, for an interquartile range increase in nitrate). $PM_{2.5}$, elemental carbon, and organic carbon during early pregnancy were also associated with wheezing. Positive IgE results to dust mites and furry animal allergens were significantly associated with increased exposure estimates to many chemical components, including sulfate and organic carbon during pregnancy. In the stratified analyses by examination year, the associations of increased exposures to chemical components with wheezing and positive IgE to some allergens were prominent in 2019, but no association was observed in 2020. Thereafter, the associations returned to being weakly significant in 2021. The risks of lifestyle-related diseases, including obesity, HbA1c, and lipids, were not associated with exposures to air pollutants during pregnancy. However, high values in total and LDL cholesterols were related to increased exposures to $PM_{2.5}$ and some other chemical components after childbirth. The associations were significant in 2019 and 2021 in stratified analyses by examination year.

Conclusions: Exposures to chemical components, including nitrate and elemental carbon, during pregnancy and early childhood were associated with wheezing and positive IgE to some allergens. These associations were not observed in 2020 when the COVID-19 pandemic occurred. This may be due to lifestyle changes such as not going outside.

[References]

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