

Research Brief 357: Early Life Exposures May Shape Infant Immune System

Exposure to certain chemicals during early pregnancy may influence how a baby's immune system develops, according to a study partly funded by the NIEHS Superfund Research Program, or SRP. The scientists discovered that some per- and polyfluoroalkyl substances, commonly referred to as PFAS, and metals may alter how an infant's immune system responds to environmental triggers.

Past research has connected high levels of PFAS and metals in blood to atopic diseases. These are allergic conditions, like asthma and food allergies, that arise when the immune system overreacts to normally harmless substances. These conditions have been linked to abnormal levels of immune markers, like white blood cells that defend the body against infections, and cytokines, which are proteins released by white blood cells. However, it is unknown how different chemicals affect these immune markers.

The research team, led by Dr. Andres Cardenas, a professor at Stanford University and project leader at the University of California, Berkeley SRP Center, aimed to clarify how chemicals affect immune markers. They used data from the Project Viva study, a cohort of mothers and their babies from eastern Massachusetts who have been followed since 1999.

First, the scientists tested blood samples from pregnant women, collected during the first trimester of pregnancy, for six types of PFAS, six non-essential metals, and four essential metals. After babies were born, umbilical cord blood was collected and white blood cells were exposed to common allergens like egg, dust mites, cockroaches, and plant proteins. Then, the team measured changes in white blood cell numbers and cytokine levels. Using statistical analyses, they estimated the association between the different chemicals measured in mothers and immune markers in cord blood following allergen exposure.

Higher prenatal levels of the PFAS chemical MeFOSAA in mothers' blood were linked to higher white blood cell levels in response to egg proteins. An overabundance of white blood cells can contribute to allergies, autoimmune disorders, and chronic inflammation. Conversely, MeFOSAA was associated with lower production of the pro-inflammatory cytokine IFN- γ in response to dust mites. Low levels of IFN- γ can hinder the immune system's ability to fight pathogens.

Exposure to the toxic metal cesium during pregnancy was associated with lower levels of the anti-inflammatory cytokine IL-10—a crucial regulator that prevents immune overreactions—in response to dust mites. Prenatal mercury exposure was linked to increased levels of the pro-inflammatory cytokine IL-13, a response connected to asthma and other allergic diseases, after exposure to plant proteins. Also, in samples exposed to plant proteins, the essential metals selenium and zinc were associated with higher levels of TNF- α , another cytokine that, if produced excessively, could contribute to autoimmune conditions.

These findings suggest that exposure to certain chemicals during pregnancy might affect how a baby's immune system develops, possibly influencing the risk of developing allergies or other immune-related issues later in life, according to the authors. More studies evaluating the link between their findings and development of atopic diseases in childhood are needed, the researchers added.

If you'd like to learn more about this research, visit the Superfund Research Program website at niehs.nih.gov/srp. From there, click on the Research Brief title under the banner, and refer to the additional information listed under the research brief. If you have any questions or comments about this month's podcast, send an email to srpinfo@niehs.nih.gov.

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