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Illuminating the Immune-Modulating Effects of PFAS Exposure in Pregnancy and Childhood

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Existing experimental and limited human studies reveal a range of immune-modulating effects of PFAS exposure, including influencing the innate and adaptive immune responses through cytokine, immunoglobulin, and immune cell activation. For assessment of adverse effects on the immune system, the response to vaccines is close to ideal as it involves administration of a well-defined dose at a particular age and subsequent measurement of the specific antibody in serum using standardized methods. Certain immunotoxic pollutants such as dioxins and PCBs are known to decrease the efficacy of vaccinations. Diphtheria and tetanus vaccines are based on proteins that elicit both T-cell and B-cell responses, representing an integrated immune system response. PFAS exposure during vulnerable windows has also been linked to lowered vaccine responses. Results from our birth cohort in the Faroe Islands showed that higher maternal serum-PFAS concentrations in pregnancy were associated with lower vaccine antibody concentrations against diptheria and tetanus among children at age 5. Importantly, estimated PFAS exposures during infancy were shown to decrease vaccine antibody levels at age 5 years. These data suggest that early postnatal exposure may be a highly vulnerable window for PFAS immunotoxity as it coincides with the development of the "learned" or adaptive immune system that is responsible for recognition of foreign antigens. For this reason, the transfer of PFAS via human milk has become an important risk factor that may predict lower antibody responses later in childhood. A doubling of PFAS exposure in infancy may decrease the serum-antibody concentration by as much as 50%, possibly rendering vaccination ineffective. Emerging data also suggest an increased incidence of childhood infections, and possibly a higher risk of asthma and allergies with elevated exposures in early chilhood. These findings should be interpreted in the light of the necessary integrity of the immune system rather than as risk of developing a specific disease. The immune system has many crucial functions, and immunotoxicity is one of the possible mechanisms that could lead to an increased cancer risk. Given that adverse effects on vaccine efficacy has been observed at low background exposures, immunotoxicity may constitute the critical effect which should drive PFAS exposure limits and preventive efforts.