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**Title**

Prenatal Perfluoroalkyl Substance Exposure and Child Adiposity at 8 Years of Age: The HOME Study

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**Abstract****Background**

Perfluoroalkyl substances (PFAS) are a group of man-made chemicals found in oil, water-resistant textile coatings, non-stick cookware, food container coatings, floor polish, fire-fighting foam, and industrial surfactants. They have the ability to accumulate and persist in the bodies of exposed individuals for many years, and are associated with adverse health outcomes including: low birth weight, delayed puberty, elevated cholesterol levels, and reduced immunologic responses to vaccinations.<sup>1</sup> Additionally, the U.S. Environmental Protection Agency's (EPA) Science Advisory Panel concluded that at least one class of PFAS - perfluorooctanoic acid (PFOA) - is a likely human carcinogen.

PFAS are also suspected obesogens (chemicals that disrupt the endocrine system and promote weight gain) because they influence energy metabolism and appetite. Childhood obesity remains a serious public health problem in the United States (U.S.), where, approximately 15% of children are overweight and 17% are obese<sup>2,3</sup>. Once adiposity, the state of being obese, is established, it is difficult to reverse, and it is linked to the development of health problems including diabetes, heart disease, chronic obstructive pulmonary disease (COPD), and musculoskeletal disorders. Studies investigating the association of prenatal PFAS exposures to the development of childhood obesity have not yielded consistent results.

**Objective**

To investigate whether prenatal PFAS exposure is associated with adiposity in children (between 2 and 8 years of age) born to women who lived downstream from a fluoropolymer manufacturing plant during pregnancy.

**Methods**

Data from a cohort study (the HOME Study) which, from March 2003 to January 2006, recruited pregnant women from nine prenatal clinics in Cincinnati, Ohio was used. These women were living downstream from a fluoropolymer manufacturing plant, and thus had median serum PFOA concentrations that were more than two times higher than pregnant women in the U.S.

Concentrations of PFOA and other PFAS classes--perfluorooctane sulfonic (PFOS), perfluoronanoic (PFNA), and perfluorohexane sulfonic (PFHxS) acids--were measured in prenatal serum samples of the study participants, collected during their 16<sup>th</sup> and 26<sup>th</sup> weeks of pregnancy and at the time of delivery. These concentrations were categorized into terciles (3 levels of exposure) in order to assess any association with child adiposity.

Children and parents returned to the study clinic at 2, 3, 4, 5, and 8 years of age. Children's height and weight measurements were assessed at each of these visits. In addition, at age 8, the children's waist circumference, and body fat were measured. Age and sex-specific BMI (body mass index) scores were calculated to determine adiposity.

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<sup>1</sup> Perfluorinated Chemical (PFC) Research. (2015, October 26). Accessed on January 13, 2016, from <http://www.epa.gov/chemical-research/perfluorinated-chemical-pfc-research>

<sup>2</sup> Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity in the United States, 2009-2010. NCHS Data Brief. 2012;(82):1-8.

<sup>3</sup> U.S. National Institute of Environmental Health Sciences. Obesity and the Environment. April 2005. Available from: <http://www-apps.niehs.nih.gov/conferences/drcpt/oe2005/factsheet.pdf>. Accessed 20 June 2006.

Potential confounders (variables which might be associated with both PFAS levels and child adiposity) were adjusted for in the data analysis, and included: maternal race, age, education, marital status, employment, and household income. Perinatal variables included maternal depressive symptoms at 16 weeks gestation, BMI at 16 weeks gestation, parity, and measurements of tobacco smoke exposure. Dietary variables included the frequency of fresh fruit/vegetable and fish consumption during pregnancy, as well as prenatal vitamin use.

### Results

Children born to women in the top two PFOA terciles had greater adiposity at 8 years than children in the 1st tercile. For example, waist circumference was higher among children in the 2nd and 3rd tercile compared to children in the 1st tercile. Children in the top two PFOA terciles also had greater BMI gains from 2 to 8 years compared to children in the 1st tercile. PFOS, PFNA, and PFHxS were not associated with adiposity.

### Conclusion

Exposure to higher prenatal serum PFOA concentrations were associated with a greater risk of adiposity at 8 years and a more rapid increase in BMI between 2- 8 years old.

### Policy Implications

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EPA has not yet established legal limits for PFOA, citing a need for more research on human health effects of exposure. However, Minnesota, New Jersey, and North Carolina have established guidelines and limits for the compound's concentration in drinking water at the state level. In the absence of regulations, EPA's Office of Water established provisional health advisories for PFOA in 2009, and EPA Region 4 recommended residential soil screening levels.

Pregnant and lactating women may be exposed to PFASs in the workplace, but the Occupational Safety and Health Administration (OSHA) has not established limits for workplace exposure.

Certain PFASs can leach into food from food packaging. In January 2016 the U.S. Food and Drug Administration issued a new rule to ban the use of 3 PFAS-related compounds in food packaging, specifically for use as oil and water repellants for paper and paperboard for use in contact with aqueous and fatty foods. This action is in response to a petition filed in October 2014 by leading environmental and public health advocates including the Children's Environmental Health Network (CEHN).

In addition to the need to establish legal limits, the need for monitoring and enforcement actions are crucial. There needs to be sufficient funding on the state and federal levels so investigation, identification and remedial actions can take place if PFOAs are present at levels exceeding standards.

In 2006, EPA, along with the eight major fluoropolymer and telomer manufacturers launched the voluntary 2010/15 PFOA Stewardship program. These companies committed to work toward elimination of PFOA, precursor chemicals, and related chemicals from emissions and products by 2015. Progress reports (as of 2014) for the companies can be found here: <http://www.epa.gov/oppt/pfoa/pubs/stewardship/>. A final status update is needed, as well as an action plan for companies to fully achieve this elimination if the 2015 goal has not been met.

It is important that EPA continue to evaluate PFAS alternatives under its New Chemicals Program. The replacement chemicals (which are very similar to PFOA and PFOS) marketed by the Stewardship program's participating companies should be thoroughly tested for human health effects, especially for effects on the most vulnerable populations. For more information on alternatives to PFASs, visit <http://www.epa.gov/assessing-and-managing-chemicals-under-tsca>.

### Reference

[Article available in Obesity.](#)

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### Keyword(s)

Perfluoroalkyl substances (PFAS), perfluorooctanoic acid (PFOA), obesogens