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Title

Early childhood adversity potentiates the adverse association between prenatal organophosphate pesticide exposure and child IQ: the CHAMACOS cohort

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Abstract

Background

Organophosphates (OPs) are a group of chemicals created initially, in the 1930-40s, for use as warfare nerve agents. By the 1950-60s, many OP chemicals were being used as insecticides. While formulated to achieve insect death, OPs also pose harmful human health effects. Humans are primarily exposed through: skin absorption from directly handling and applying OPs; breathing in OPs as they are applied or as they drift from the application site; and eating foods (even dust)/drinking water that contain OP residues. Chronic exposure to low levels of OPs increases the risk of developing disorders of the nervous system (brain, spine and nerves), and extremely high levels of exposure can cause comas and even death[1]. Prenatal exposures are associated with reduced birth weight, head circumference, and gestational length in infants, and prenatal and postnatal exposures have been linked with altered reflexes, inattention, behavior problems, lowered IQ, and developmental disorders in infants and toddlers[2]. In addition, recent research findings indicate potential associations of OP exposure with pediatric asthma, cancer, and birth defects[3].

Several studies have found that early life stressors may intensify the effects of environmental chemical exposure on brain and nervous system development in animals. Few studies have specifically considered the potential role of social stressors, such as poverty, maternal depression, and family conflict, in modifying the effects of OP exposure on children's IQ or other areas of cognition.

Objective

This study examined how social stressors may play a role in influencing the relationship between OP exposure and child IQ levels in a Mexican American agricultural population.

Methods

Participants from the Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS) study included 329 singleton infants and their mothers followed from pregnancy through age 7. Concentrations of dialkyl phosphate metabolites (DAPs), which are substances that indicate OP exposure, were measured in maternal urine collected twice during pregnancy and averaged. Child IQ was assessed at 7 years of age. Demographic characteristics and adversity information were collected during interviews and home visits at numerous time points from pregnancy until age 7.

Results

The mothers in the study were predominately Latina, and 40% of them worked in agriculture during their pregnancies. Seventy percent of the women were low income and 15% were determined to be at risk of depression.

Greater total adversity and specific domains of adversity, including poor learning environment and adverse parent-child relationships, were associated with lower child IQ scores. Adverse associations between DAP concentrations and IQ

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[2] Chronic Health Implications. Retrieved September 01, 2016, from http://depts.washington.edu/opchild/chronic.html
[3] Chronic Health Implications. Retrieved September 01, 2016, from http://depts.washington.edu/opchild/chronic.html

were stronger in children experiencing greater adversity; these associations varied by child sex. For example, the association between prenatal OP exposure and Full-Scale IQ is heightened among boys who experienced high adversity in the learning environment.

Conclusion

Previous studies have found that prenatal exposure to OPs is associated with reduced IQ in children. However, this study shows an even stronger association between OP exposure and IQ in children who have and are experiencing social stress and early life adversity. The results also reveal that a child's sex may influence how various adversities impact the relationship between OP exposure and IQ.

Policy Implications

This study's findings not only support similar research on how chemical and non-chemical exposures have interacted to influence health and development in animal studies, but is also one of very few studies to explore this interaction in humans. Additional research in this area is needed, especially to investigate the plausible interactive pathways between social adversities and environmental exposures. Even so, risk assessments designed to inform OP regulations should consider children's cumulative exposures, including non-chemical exposures such as social stress, in order to best protect some of our most vulnerable children.

The use of OPs has been decreasing in the United States (US), but is still being applied, primarily for agricultural uses. In 2007, 33 million pounds of the insecticide were applied[4]. In 2015 the U.S. Environmental Protection Agency (EPA) made revisions to the 1992 Agricultural Worker Protection Standard which goes into effect January 2017[5]. While these revisions seek to reduce pesticide exposure to farmworkers, there continues to be a need for policies to reduce pesticide drift. A chief concern of OP use, pesticide off-target drift is the potential for pesticides used for agricultural purposes to be dispersed and carried by wind to surrounding areas. Homes, child care facilities and schools near agricultural land where OPs are applied are likely to have higher levels of OPs in their dust than those farther from the application[6]. In 2012 EPA established "no-spray" buffer zones around public spaces and homes and in 2014 the Agency launched a voluntary program (the Pesticide Drift Reduction Technology program) to combat pesticide drift by incentivizing manufactures and users to improve the technology associated with dispersing pesticides. However, voluntary programs cannot provide the level of protection necessary to safeguard children's health. Agricultural workers and their families, as well as those living or attending schools near fields where OPs are applied, continue to be at risk of higher exposures. Policies and rules at the state and local level are needed to better protect these children's health.

Another OP exposure pathway is through diet. The Food Quality Protection Act (FQPA) of 1996 places emphasis on the health protection of children and infants with regard to setting limits on pesticide residues on foods for human consumption and requires EPA to review pesticides periodically while considering new scientific research[7]. It is important that cumulative exposures, including non-chemical exposures such as those examined in this study, as well as children most at risk to high OP exposures be considered in the EPA's review process.

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Keyword(s)

Pesticides, Chemical Exposures, Organophosphates, Neurotoxicants, Child IQ