February Article of the Month

Association between prenatal exposure to ambient diesel particulate matter and perchloroethylene with children's 3rd grade standardized test scores

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ABSTRACT

Background:

Diesel is a common urban pollutant--a mixture of over 100 distinct components including particulate matter--often encountered as a traffic-related air pollutant (TRAP). Children can be exposed to high levels of diesel if they live near busy roads, rail lines or railyards, and while riding in old diesel-fueled school buses, or when near such buses that are idling. Diesel pollution has been linked to various health effects including asthma attacks and the development of cancer. Prenatal exposures are of significance as well. Prenatal TRAP exposure has been linked to adverse neurodevelopmental and behavioral outcomes in children[1].

Perchloroethylene (perc) is a liquid solvent commonly used in dry cleaning that readily evaporates into the air. In urban environments, individuals can be exposed to high levels of perc if they live near dry cleaning or chemical waste facilities[2]. Perc has been associated with adverse brain development and behavior outcomes in animal studies, and recent research has shown associations of prenatal exposure with autism in children[3].

Diesel and perc commonly co-occur in urban environments. Both air pollutants have been studied separately for their individual effects on human health, but few, if any, studies have examined the effects of these chemicals combined.

Objective:

To determine whether prenatal exposure to ambient diesel particulate matter (PM) and perc have an effect on children's 3rdgrade standardized test scores in math and English language arts (ELA).

Methods:

Study population and academic performance:

The researchers used 3rd grade math and ELA test scores of 201,559 single children born between 1994 and 1988 and attending New York public schools. For study analysis purposes, test scores were divided into 2 variables; below test-based standards or met/exceeded test-based standards.

Exposure assessment:

Using the U.S. Environmental Protection Agency's (EPA's) National Air Toxics Assessment (NATA) data and the corresponding census tract of the address on the children's birth records, diesel and perc

prenatal exposure levels were assigned to each child. For each pollutant, concentrations were categorized into quartiles (4 levels).

A neighborhood-deprivation index was created to account and adjust for factors like lead exposure, educational attainment, employment status, and socio-economic status which may influence academic outcomes and act as confounders.

Results:

Children prenatally exposed to the highest levels of diesel PM and perc combined had lower math scores than children exposed to lower levels of the combined pollutants. There was no association found between exposure to both pollutants and failing to meet ELA standards. However, for low ELA scores, a small association was found for high exposure to perc.

Conclusion:

Prenatal exposure to high levels of co-occurring diesel and perc was associated with decreased academic outcomes specific to math performance. The researchers acknowledge that a limitation of this study is that the results could potentially be influenced by other pollutants not observed in this study. However, this study suggests that there is potential for pollutants to have a greater effect on children when 2 or more occur simultaneously versus separately.

POLICY IMPLICATIONS

The federal government recognizes that both diesel and perc pose risks to human health, and has implemented various measures to reduce these exposures.

Perc

Place-based protection: Much of human exposure to perc is through occupational exposures, especially in the dry cleaning industry. Thus, the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) established a standard permissible exposure level for workers at 100 parts per million (time-weighted average concentration for a normal 8-hour workday) [4]. Consideration of a tighter standard to account for prenatal exposures from mothers in the workplace is important.

Air, Water, and other Media Regulations: The U.S. Environmental Protection Agency (EPA) has set a maximum contaminant level for perc in drinking water at 5 ppm for adults and recommends children should not be exposed to more than 2 ppm in water in a day due to its hazardous nature [5]. However, the majority of the general population is exposed to perc through indoor and outdoor air. Perc is listed as a hazardous air pollutant under the Clean Air Act, but emissions are not yet regulated in ambient air. Enforceable air standards may help protect children and pregnant women who live adjacent to or in the same building as dry cleaning businesses or other sources of perc emissions.

In November of 2016, EPA announced the first ten chemicals that will be assessed in 2017 under the Toxic Substances Control Act revision. Recommendations resulting from the assessments are required to be health-based, and in particular, protective of children and vulnerable populations. Perc is included in the list and will be extensively evaluated for potential health and environmental harms [6]. Study

findings such as those presented in this article add to existing evidence that prenatal perc exposure is linked with neurodevelopmental effects, and should be considered in EPA's review [7]. Also, EPA is seeking public input around the top ten list. If you would like to provide comments on perc, click on the link included below.

Please share your input regarding the Top 10 list (including perc): https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/evaluating-risk-existing-chemicals-under-tsca

Diesel

Cleaner burning fuel and retrofitting existing engines are safer and healthier alternatives, which can be adopted through use of new technologies and regulations.

President Obama signed into law the Diesel Emissions Reduction Act (DERA) of 2010. DERA has invested $100 million to provide grants for projects and technology to reduce emissions until the 2016 fiscal year. Seventy percent of the funds have been allocated for national competitive grants that follow EPA or California Air Resources Board (CARB)'s certified diesel reduction technology and the remaining thirty percent is distributed to states [8],[9].

Between 2009 and 2013, the DERA program has retrofitted or replaced about 58, 800 engines in locomotives, vessels, and vehicles, however there still remains 10.3 million in use [10]. Also, early January, DERA funded $7.7 million dollars to 88 school buses in order to retrofit or replace the engines. Additionally, EPA's Clean School Bus national program encourages communities to reduce emission. The program offers funding for projects that reduce emissions from existing diesel engines [11].

Children in many communities, however, are still exposed to older school buses which do not meet newer, "cleaner" EPA requirements. While efforts to retrofit or replace these older buses is ongoing, stronger idling policies around schools and child care facilities are needed to best protect children [12].

A regulatory model such as that enacted by the state of California would have greater impact. California established strict requirements for diesel truck and bus owners, including a mandate that all trucks and buses engines older than 2010 need to be replaced by 2023 [13].

REFERENCE

[1] Harris, M.H., Gold, D.R., Rifas-Shiman, S.L., Melly, S.J., et al.,2015. Prenatal and Childhood Traffic-Related Pollution Exposure and Childhood Cognition in the Project Viva Cohort (Massachusetts, USA). Environ. Health Perspect. 123, 1072-1078.

[2] Perchloroethylene (PCE, PERC). 2016. Retrieved 25 January 2017, from https://toxtown.nlm.nih.gov/text_version/chemicals.php?id=22

[3] NH Department of Environmental Services Tetrachloroethene: Health Information Summary. 2012. Retrieved 25 January 2017, from http://www.des.nh.gov/organization/commissioner/pip/factsheets/ard/documents/ard-ehp-18.pdf

[4] ATSDR - Public Health Statement: Tetrachloroethylene (PERC). (2017). Atsdr.cdc.gov. Retrieved 25 January 2017, fromhttp://bit.ly/2kQPgD1

[5] Fact Sheets on Hazardous Substances. (1993). Google Books. Retrieved 25 January 2017, from http://bit.ly/2knwINX

[6] EPA Names First Chemicals for Review Under New TSCA Legislation | U.S. EPA News Releases | US EPA. (2017). Epa.gov. Retrieved 25 January 2017, from http://bit.ly/2gghpnS

[7] Registry, A. (2017). Tetrachloroethylene |Toxzine | ATSDR. Atsdr.cdc.gov. Retrieved 25 January 2017, fromhttp://bit.ly/2kMCmGU

[8] DIESEL EMISSIONS REDUCTION ACT OF 2010. (2011). Retrieved 25 January 2017, from http://bit.ly/2kQIzke

[9] Learn About Clean Diesel | Clean Diesel and DERA Funding | US EPA. (2017). Epa.gov. Retrieved 25 January 2017, fromhttp://bit.ly/2kOfom4

[10] Third Report to Congress: Highlights from the Diesel Emission Reduction Program. (2016). Retrieved 27 January 2017, fromhttp://bit.ly/2jR8mLC

[11] EPA Rebates Will Fund Cleaner School Buses in 88 Communities | U.S. EPA News Releases | US EPA. (2017). Epa.gov. Retrieved 31 January 2017, from http://bit.ly/2i19cUZ

[12] Clean School Bus | Clean Diesel and DERA Funding | US EPA. (2017). Epa.gov. Retrieved 25 January 2017, fromhttp://bit.ly/1QT8IXs

[13] On-Road Heavy-Duty Diesel Vehicles (In-Use) Regulation. (2017). Arb.ca.gov. Retrieved 25 January 2017, fromhttp://bit.ly/2kd08fl

Article found in Science Direct.