Effect of exposure to polycyclic aromatic hydrocarbons on basal ganglia and attention-deficit hyperactivity disorder symptoms in primary school children

Marion Mortamais, Jesus Pujol, Barend L. van Drooge, Didac Macià, Gerard Martínez-Vilavella, Christelle Reynes, Robert Sabatier, Ioar Rivas, Joan Grimalt, Joan Forns, Mar Alvarez-Pedrerol, Xavier Querol, Jordi Sunyer

Environment International, Volume 105, August 2017, Pages 12-19

Abstract

Background
Polycyclic aromatic hydrocarbons (PAHs) have been proposed as environmental risk factors for attention deficit hyperactivity disorder (ADHD). The effects of these pollutants on brain structures potentially involved in the pathophysiology of ADHD are unknown.

Objective
The aim of this study was to investigate the effects of PAHs on basal ganglia volumes and ADHD symptoms in school children.

Methods
We conducted an imaging study in 242 children aged 8–12 years, recruited through a set of representative schools of the city of Barcelona, Spain. Indoor and outdoor PAHs and benz[a]pyrene (BPA) levels were assessed in the school environment, one year before the MRI assessment. Whole-brain volumes and basal ganglia volumes (caudate nucleus, globus pallidus, putamen) were derived from structural MRI scans using automated tissue segmentation. ADHD symptoms (ADHD/DSM-IV Scales, American Psychiatric Association 2002) were reported by teachers, and inattentiveness was evaluated with a standard error of hit reaction time in the attention network computer-based test.

Results
Total PAHs and BPA were associated with caudate nucleus volume (CNV) (i.e., an interquartile range increase in BPA outdoor level (67 pg/m3) and indoor level (76 pg/m3) was significantly linked to a decrease in CNV (mm3) (β = − 150.6, 95% CI [− 259.1, − 42.1], p = 0.007, and β = − 122.4, 95% CI [− 232.9, − 11.8], p = 0.030 respectively) independently of intracranial volume, age, sex, maternal education and socioeconomic vulnerability index at home). ADHD symptoms and inattentiveness increased in children with higher exposure to BPA, but these associations were not statistically significant.

Conclusions
Exposure to PAHs, and in particular to BPA, is associated with subclinical changes in the caudate nucleus, even below the legislated annual target levels established in the European Union. The behavioral consequences of this induced brain change were not identified in this study, but given the caudate nucleus involvement in many crucial cognitive and behavior processes, this volume reduction is concerning for the children’s neurodevelopment.