JOHNS HOPKINS
BLOOMBERG SCHOOL
of PUBLIC HEALTH

February 12, 2020

Written Testimony In Support Of
HB 229– Pesticides –Use of Chlorpyrifos - Prohibition
Submitted to: The Maryland House of Delegates Environment and Transportation Committee

Honorable Chairman and Members of the Committee,

My name is Lesliam Quirós-Alcalá and I am an Assistant Professor in the Department of Environmental Health and Engineering at the Johns Hopkins Bloomberg School of Public Health and an Adjunct Assistant Professor at the Maryland Institute of Applied Environmental Health at the University of Maryland, School of Public Health. I am also on the Scientific Advisory Board for the Children's Environmental Health Network, a national multi-disciplinary non-governmental organization based in Washington DC whose mission is to protect children from environmental health hazards.

I am an environmental health scientist by training with expertise in children's environmental health, exposure assessment, occupational health, and environmental epidemiology. For over a decade, my research has focused on studying exposures to environmental chemicals, including pesticides, in children and other vulnerable populations, and the potential effects of these exposures on human health.

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I am submitting this testimony in strong support of HB 229 to prohibit the use of chlorpyrifos and other insecticides containing chlorpyrifos in the state of Maryland based on my prior work and the weight of the evidence from several peer-reviewed scientific studies.

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Prior to starting my first faculty appointment in 2014, I conducted research with colleagues at the Center for Environmental Research and Children's Health (CERCH) at the University of California at Berkeley. The Center is one of the initial vanguard Centers of Excellence in Children's Environmental Health and Disease Prevention Research jointly funded in 1998 by the U.S. Environmental Protection Agency (EPA) and the National Institutes of Environmental Health Sciences (NIEHS)to study the effects of chemicals on children's health.

Over the last 20 years, CERCH has led the Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS) study. The CHAMACOS study enrolled 601 pregnant women between 1999-2001 living in an agricultural community in Salinas Valley, CA to study the effects of pesticides like chlorpyrifos (and other chemicals) on children's health. Researchers have assessed chemical exposures in the CHAMACOS cohort during pregnancy and childhood and have been following the children for 19 years. Data from the CHAMACOS study has been instrumental in contributing to the scientific literature on the potential adverse effects of chemicals on children's health.

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Based on research findings from the CHAMACOS study and that of others, one of the major concerns with chlorpyrifos is its potential to affect children's neurodevelopment.

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Chlorpyrifos belongs to a class of pesticides known as organophosphate (OP) pesticides. OP pesticides have a common mechanism of toxicity and are designed to affect the central nervous system. Chlorpyrifos inhibits an enzyme (acetylcholinesterase) which regulates nerve impulses in the body. Most people are exposed to chlorpyrifos through their diet by eating fruits and vegetables (e.g., apples, broccoli, grapes) that have been treated with these pesticides. Exposures may also occur by inhalation or skin absorption when applying pesticides; working in agricultural fields, golf courses, or other areas treated with pesticides; and by living or going to school near treated sites.[1-3]

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Evidence from the CHAMACOS study has shown that exposure to OP pesticides, including chlorpyrifos, during pregnancy is associated with increased risk of mental, motor, and behavioral problems in children, including:

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- Abnormal reflexes in infants (abnormal reflexes suggest neurological problems) [4]
- Poor mental development among preschoolers[5]
- Attention problems and hyperactive behavior at age 5 years[6]
- Poor mental development at age 7 years (e.g., decreases in IQ points, working memory, processing speed, verbal comprehension, perceptual reasoning,) [2, 7]

Similar findings have been documented by other U.S. researchers at other universities, including Columbia and Mt. Sinai, as well as in other countries in both urban and farmworker pediatric populations. [3, 8-10] Overall, studies have shown that exposure to OP pesticides, including chlorpyrifos, during pregnancy is associated with mental, motor, and behavioral problems. Specifically, abnormal reflexes in infants; mental and motor delays among preschoolers; decreases in working and visual memory, processing speed, verbal comprehension, perceptual reasoning, and IQ among school-aged children; and increased risk of symptoms or diagnoses of attention-deficit hyperactivity disorder (ADHD) and autism spectrum disorder (ASD).[3] A recent study also showed that children with high levels of chlorpyrifos in umbilical cord blood had an increased risk of altered brain structure.[11]

Altogether, these peer-reviewed studies indicate that outcomes associated with exposure to OP pesticides like chlorpyrifos during pregnancy are consistent and persistent, with associations observed from early infancy into late childhood.

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The majority of OP pesticide studies linking exposure to altered neurodevelopment have relied on objective measures of exposure generated according to scientifically established protocols and reported similar findings.

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Accurate measurement of exposure is critical in any human study trying to establish an association between an exposure to an environmental agent and a particular health outcome. OP pesticide studies in the literature have assessed exposures in various ways, including by directly measuring OP pesticides or their breakdown products in biological samples (urine, blood) to quantifying nearby pesticide use by geographically linking home addresses with pesticide use reporting databases available.[3] Objective measures of exposure have been used and generated according to scientifically established protocols in the vast majority of studies reporting a link between OP pesticides and altered neurodevelopment. These measures have also been obtained independently of the child's outcome.

It is important to highlight that pesticide studies have assessed exposure among different pediatric populations (e.g., urban and farmworker children), in different geographic locations, and have used different methods of measuring pesticide exposure. However, it is these differences that bolster the weight of the evidence that OP pesticides like chlorpyrifos are likely detrimental to children's brains. *Peer-reviewed studies have shown similar consistent findings spanning from early to late childhood despite these study differences.*

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Scientists in academia and the U.S. EPA agree that low level exposures to chlorpyrifos are of great concern and present a clear risk to children's health.

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Based on findings from human studies, EPA scientists concluded that there is "*sufficient evidence that there are neurodevelopmental effects occurring at chlorpyrifos exposure levels below those required to cause acetylcholinesterase inhibition."* [12] That is, reliance of acetylcholinesterase inhibition for regulatory purposes to assess the potential health risks of OP pesticides in children masks the serious threat that OP pesticides pose on children's developing brains.

In 2016, EPA scientists also concluded that based on current labeled uses in the U.S., exposure to chlorpyrifos from either food or drinking water alone could lead to unacceptably high exposures and that some women of reproductive age, infants, and children consume levels of chlorpyrifos that exceed those considered acceptable for these vulnerable stages.[12]

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Continued used of chlorpyrifos puts vulnerable and marginalized populations at risk of adverse effects related to these pesticides, representing an environmental justice concern

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Farmworkers and their families, and residents living in agricultural rural communities characterized by poverty and limited access to basic resources are at an elevated risk of experiencing higher exposures to chlorpyrifos, placing them at an increased risk of adverse health effects. Exposures may occur from working in the fields and living or going to schools near treated fields. Pesticide exposures may also occur when farmworkers bring pesticides into the home on their clothing or shoes.[13, 14]

Data from the CHAMACOS study and ancillary CERCH studies show that:

(1) pregnant women living in an agricultural community experience significantly higher exposures to chlorpyrifos and other OP pesticides compared to pregnant women from the U.S. general population; [15]
(2) residential proximity to agricultural fields where chlorpyrifos is applied is associated with lower IQ at 7 years of age[2]
(3) pesticides used solely in agriculture are found in residences in agricultural communities; [16]

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Comprehensive steps are critical to protect our children and other vulnerable populations so they can become thriving contributing members of our society as the potential health effects of chlorpyrifos also represent an economic burden to our state and our nation.

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The economic costs associated with neurodevelopmental problems cannot be ignored. It is estimated that, on average, it costs twice as much to educate a child with learning or developmental disabilities in the U.S. compared to the costs associated with educating children without these disabilities.[17] A recent analysis in the European Union reported that annual costs linked to the loss of IQ points and learning disabilities due to chemical exposures, including OP pesticides, were estimated to be $169.43 billion dollars.[18] The detrimental effects of the OP chlorpyrifos on health place children and other vulnerable populations at a clear disadvantage, limiting their ability to become contributing members of our society and resulting in economic consequences to our state and our nation.

In summary, the science is clear and consistent: chlorpyrifos is putting the health of our children and other vulnerable populations at risk.

I strongly support the passage of House Bill 229 to ban all uses of chlorpyrifos in the state of Maryland and urge our decision makers to not dismiss the use of sound science and the current weight of the evidence in decision-making to promote and ensure public health.

Sincerely,

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February 12 , 2020

Re: HB229 – Pesticides – Use of Chlorpyrifos – Prohibition
Submitted to: The House Environment and Transportation Committee
Position: In support of HB 229

Chairman Pinsky and Members of the Committee,

I am an Associate Professor in the Department of Environmental Medicine and Public Health at the Icahn School of Medicine at Mount Sinai in New York. I investigate the relationship between early life exposure to environmental toxicants and adverse neurodevelopmental outcomes, including changes in children's brain structure and function. I am providing this written testimony as an environmental health expert and as a leading researcher in the studies finding that exposure to chlorpyrifos harms children's brains.

I strongly support the passage of House Bill 229 to ban all uses of chlorpyrifos in the state of Maryland. Consistent evidence across animal studies and epidemiological studies demonstrate that chlorpyrifos is a powerful developmental neurotoxicant and that early life exposure to chlorpyrifos is associated with persistent adverse outcomes in children, including changes in brain structure. I believe this bill is essential to help protect the health of Maryland's most vulnerable populations: pregnant women and children.

The scientific evidence of neurotoxic dangers associated with chlorpyrifos exposure is extensive and consistent. Three recent epidemiologic studies demonstrate that exposure to chlorpyrifos during pregnancy is harmful to children's brains and that damage persists throughout childhood. These three studies, based on different populations, located in distinct geographical regions of the US, and using different biomarkers of exposure, have produced strongly convergent results. One study from the University of California at Berkeley reported reductions in IQ scores among the children of agricultural workers in the Salinas Valley. The second study was undertaken at my institution, the Icahn School of Medicine at Mount Sinai, and found similar results in a New York City Hispanic population. The third study, also conducted in New York City by investigators at Columbia University among a population of African-American and Dominican children determined that prenatal chlorpyrifos exposure negatively impacted children's brain development. These data sets all support the need to protect children from early life exposure to chlorpyrifos.

Building upon these epidemiologic studies demonstrating associations between early life chlorpyrifos exposure with behavioral and cognitive outcomes in children, Columbia University undertook an MRI study to inform our understanding of the influence of prenatal and early childhood chlorpyrifos exposure on brain regions regulating behavior and cognition in children. In this work, we evaluated the brains of 40 children, ages 5 to 11, whose mothers were enrolled during pregnancy into the Columbia University Mother's and Newborn's Study. This is a non-clinical, representative community-based cohort enrolled from Northern Manhattan and the South Bronx in New York City. We compared the brain scans of 20 children with higher levels of chlorpyrifos exposure (as measured in umbilical cord blood collected at birth) to 20 age- and sex- matched control subjects with lower chlorpyrifos levels. The brain scans of children with higher chlorpyrifos exposure looked markedly different compared with those of children exposed to lower levels of chlorpyrifos. Changes were visible across the surface of the brain, with abnormal enlargements of some areas and thinning in others. Although the study did not examine specific disorders tied to any of these brain changes, the regions affected are associated with

functions such as attention, decision making, language, impulse control and working memory. These changes in brain structure are consistent with the cognitive and behavioral deficits observed in children exposed to this chemical, and consistent with animal literature linking early life exposure to low levels of these chemicals to adverse neurodevelopmental outcomes.

The high chlorpyrifos group also displayed disruption of normal sexual differences in brain structure – effects that were not observed in the low chlorpyrifos group. Expected sex differences (i.e., enlargement of the right inferior frontal lobe) were reversed in the high chlorpyrifos group. These findings are consistent with animal models suggesting that chlorpyrifos exposure reverses normal sexual differences in rates of learning, memory and emotional behaviors.

Notably, the adverse cognitive and motor outcomes and the brain abnormalities observed in these studies appeared to occur following low-level exposures to chlorpyrifos in non-occupationally exposed, community-based samples. **These affects are seen at exposure levels are below EPA safety standards**. This suggests that the mechanisms underlying brain changes may involve other pathways and occur at lower levels than anticipated based on systemic toxicity. And further, it suggests that the current EPA safety standards do no protect vulnerable populations such as the developing infant and small child from the adverse impacts of chlorpyrifos.

In summary, residential exposure to chlorpyrifos in a non-clinical, community-based sample is associated with persistent changes in the morphology of brain regions that support cognitive and behavioral outcomes. These associations occur at levels below the threshold for systemic toxicity suggesting that the fetal and developing brain is uniquely vulnerable to this chemical. These findings, together with decades of animal and epidemiologic research confirm the toxic dangers posed by exposure to even low levels of chlorpyrifos. Based on this evidence, Maryland lawmakers should enact SB 300 and ban all uses of chlorpyrifos in the state of Maryland. It is the right thing to do to protect the health of Maryland's children and future.

Megan K. Horton, PhD, MPH *is an Associate Professor of Environmental Medicine and Public Health at the Icahn School of Medicine at Mount Sinai.*

Dr. Horton is an environmental health scientist with expertise in environmental epidemiology, child neurodevelopment and pediatric neuroimaging. Following her doctoral training in environmental health at Columbia University, she completed a postdoctoral fellowship in neuroepidemiology where she learned to apply magnetic resonance imaging (MRI) to investigate the impact of prenatal exposure to pesticides and secondhand smoke on neuropsychological and behavioral function throughout childhood. In 2010, she received a prestigious NIH-funded career transition award to study co-exposure to endocrine disrupting chemicals (e.g., polybrominated flame retardants, perchlorate, pyrethroid insecticides) and structural and functional brain outcomes in a New York-based longitudinal birth cohort. This award included extensive training in study design and statistical approaches for linking early life exposures to complex chemical mixtures with neuroimaging data to evaluate changes in brain structure and function in children. Her work has been highlighted at national and international meetings.