

The Scientific Case for Banning Chlorpyrifos in Connecticut

In 2015, EPA scientists recommended a complete ban on the neuro-toxic pesticide chlorpyrifos, bolstered by foundational studies linking chlorpyrifos exposure to harms to human health:

Environmental Protection Agency. (2016). Chlorpyrifos Revised Human Health Risk Assessment. Regulations.gov. Retrieved from:

<https://www.regulations.gov/document?D=EPA-HQ-OPP-2015-0653-0454>

- The agency linked *in utero* exposure to chlorpyrifos with autism, ADHD and other neurodevelopmental issues.
- EPA estimated that children ages 1-2 are exposed to chlorpyrifos at 140 times safe levels.
- Chlorpyrifos is found at elevated levels in the air at schools, homes and communities in agricultural areas.
- All workers who mix or apply chlorpyrifos are exposed to unsafe levels of chlorpyrifos, even with maximum protective equipment.

Rauh, V.A., Garfinkel, R., Perera, F.P. Andrews, H.F., Hoepner, Barr DB, Whitehead, R., Tang, D., Whyatt, R.W. (2006). Impact of prenatal chlorpyrifos exposure on neurodevelopment in the first 3 years of life among inner-city children. Environmental Health Perspectives. Retrieved from: <https://www.ncbi.nlm.nih.gov/pubmed/17116700>

- Children exposed to high levels of chlorpyrifos scored lower on key psychomotor and neurodevelopmental Indexes than unexposed children.
- Prenatal exposure could potentially result in children needing early intervention services
- Issues were observed at 3 years of age

Rauh, V.A., Arunajadai, S., Horton, M., Frederica, P., Hoepner, L., Barr, D.B., Whyatt, R. (2011). Seven-Year Neurodevelopmental Scores and Prenatal Exposure to Chlorpyrifos, a Common Agricultural Pesticide. Environmental Health Perspectives. Retrieved from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3237355/#r47>

- Follow up from above study, now when children are 7 years of age.
- Exposed children had reduced IQ and reduced working memory by the age of 7.

Rauh, V.A., Perera, F.P., Horton, M.K., Whyatt, R.M., Bansal, R., Hao, X., Liu, J., Barr, D.B., Slotkin, T.A., Peterson, B.S. (2012). Brain anomalies in children exposed prenatally to a common organophosphate pesticide. Proceedings from the National Academy of Sciences of the United States of America. Retrieved from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3237355/#r47>

- Prenatal exposure to chlorpyrifos is associated with neurobehavioral deficits.

- Exposure from standard use levels was associated with a wide variety of physical brain abnormalities.

Rauh, V.A., Garcia, W.E., Whyatt, R.M., Horton, M.K., Barr, D.B., Louis, E.D. (2015). Prenatal exposure to the organophosphate pesticide chlorpyrifos and childhood tremor. Neurotoxicology. Retrieved from:

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4809635/#R32>

- Children exposed to high levels of chlorpyrifos were more likely to have mild or moderate tremors.
- Impacts were observed in middle childhood and may indicate effects on nervous system function.

Hertz-Picciotto, I., Sass, J.B., Engel, S., Bennett, D.H., Bradman, A., Eskenazi, B., Lanphear, B., Whyatt, R. (2018). Organophosphate exposures during pregnancy and child neurodevelopment: Recommendations for essential policy reforms. PLOS Medicine. Retrieved from:

<https://doi.org/10.1371/journal.pmed.1002671>

- Widespread use of organophosphate pesticides to control insects has resulted in ubiquitous human exposures.
- Prenatal exposure to chlorpyrifos at low levels is putting children at risk for cognitive and behavioral deficits and for neurodevelopmental disorders.

Exposure to chlorpyrifos can have reproductive effects on both men and women:

Salazar-Arredondo, E., de Jesús Solis-Heredia, M., Rojas, García, E., Hernández-Ochoa, I., Quintanilla-Vega, B. (2008). Sperm chromatin alternation and DNA damage by methyl-parathion, chlorpyrifos and diazinon and their oxon metabolites in human spermatozoa. Reproductive Toxicology. Retrieved from:

<https://www.ncbi.nlm.nih.gov/pubmed/18595656>

- Exposure to organophosphates such as chlorpyrifos alter semen quality.
- Chlorpyrifos can damage sperm DNA

Meeker, J.D., Ravi, S.R., Barr, D.B., Hauser, R. (2007). Circulating estradiol in men is inversely related to urinary metabolites of nonpersistent insecticides. Reproductive Toxicology. Retrieved from:

<https://dx.doi.org/10.1016%2Fj.reprotox.2007.12.005>

- Exposure to chlorpyrifos was associated with a decline in estradiol, which aids sperm production by facilitating germ cell survival.

Rattan, S., Zhou, C., Chiang, C., Mahalingam, S., Brehm, E., Flaws, J.A. (2018). Exposure to endocrine disruptors during adulthood: Consequences for female fertility. Journal of Endocrinology. Retrieved from:

<https://dx.doi.org/10.1530%2FJJOE-17-0023>

- Endocrine disruption from exposure to endocrine disrupting pesticides like chlorpyrifos can result in subfertility, infertility, improper hormone production and other abnormalities.
- Endocrine disruption can cause fertility issues in adults.

Solomon, G.M., Moodley, J. (2008). Acute chlorpyrifos poisoning in pregnancy: A case report. Clinical Toxicology. Retrieved from: <https://doi.org/10.1080/15563650601117988>

- Organophosphate poisoning can mimic acute pregnancy complications
- Poisoning can result in serious adverse effects for both mother and fetus

Eskenazi, B., Harley K., Bradman, A., Weltzien, E., Jewell, N.P., Barr, D.B., Furlong, C.E., Holland, N.T. (2004). Association of *in Utero* Organophosphate Pesticide Exposure and Fetal Growth and Length of Gestation in an Agricultural Population. Children's Health. Retrieved from: <https://doi.org/10.1289/ehp.6789>

- Researchers studied hundreds of women, starting early in pregnancy
- Exposure to CPY was a factor in early births for some women

And exposure is linked to an increased risk of Parkinson's Disease

Manthripragada, A.D., Costello, S., Cockburn, M.G., Bronstein, J.M., Ritz, B. (2010). Paroxonase 1, agricultural organophosphate exposure, and Parkinson disease. Epidemiology. Retrieved from:

https://www.ncbi.nlm.nih.gov/pubmed/19907334?itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum&ordinalpos=1

- Individuals with a particular genetic makeup are at more than double the risk of developing Parkinson's when exposed to chlorpyrifos
- Chlorpyrifos had an even greater effect in early-onset cases.

Freire, C., Koifman, S. (2012). Pesticide exposure and Parkinson's disease: epidemiological evidence of association. Neurotoxicology. Retrieved from:

<https://www.ncbi.nlm.nih.gov/pubmed/22627180>

- A meta-study of previous studies found that, of insecticides that may increase risk of Parkinson's, chlorpyrifos had one of the strongest associations.
- 13 of 23 studies reviewed observed a significantly increased risk of Parkinson's.

Chen, T., Tan, J., Wan, Z., Zou, Y., Afewerky, H.K., Zhang, Z., Zhang, T. (2017). Effects of Commonly Used Pesticides in China on the Mitochondria and Ubiquitin-Proteasome System in Parkinson's Disease. International Journal of Molecular Sciences. Retrieved from: <https://doi.org/10.3390/ijms18122507>

- Exposure to chlorpyrifos is associated with a number of indicators that increase risk of Parkinson's
- While previous studies linked pesticide exposure to Parkinson's, little was known as to why.
 - This study demonstrates that chlorpyrifos can increase the risk of Parkinson's through a number of different pathways.

Unfortunately, children are regularly exposed.

EPA determined that children are exposed to chlorpyrifos at 70 to 140 times safe levels through *food and drink alone*, largely because chlorpyrifos is the 4th most common pesticide found in human foods:

U.S. Food and Drug Administration (2015). Pesticide Residue Monitoring Program. Fiscal Year 2015 Pesticide Report.

- Chlorpyrifos was the fourth most common pesticide found in human foods.
- FDA detected chlorpyrifos 310 times when testing samples.

Chlorpyrifos is also extremely toxic to pollinators and aquatic life

Sanchez-Bayo, F., Goka, K. (2014). Pesticide Residues and Bees – A Risk Assessment. PLOS ONE. Retrieved from: <https://doi.org/10.1371/journal.pone.0094482>

- Chlorpyrifos is one of the most toxic insecticides to honeybees, second only to neonicotinoids.

Zhu, W., Schmehl, D.R., Mullin, C.A., Frazier, J.L. (2014). Four Common Pesticides, Their Mixtures and Formulation Solvent in the Hive Environment Have High Oral Toxicity to Honey Bee Larvae. PLOS ONE. Retrieved from: <https://doi.org/10.1371/journal.pone.0077547>

- Pesticide mixtures were highly toxic to honeybee larvae, though there has not been enough research on the total effects of multiple pesticides found in hives.
- Chlorpyrifos residues in a hive more than doubled the mortality rate of honeybee larvae.

Urlacher, E., Monchanin, C., Riviere, C., Richard, F., Lombardi, C., Michelsen-Heath, S., Hageman, K.J., Mercer, A.R. (2016). Measurements of Chlorpyrifos Levels in Forager Bees and Comparison with Levels that Disrupt Honey Bee Odor-Mediated Learning Under Laboratory Conditions. Retrieved from: <https://link.springer.com/article/10.1007/s10886-016-0672-4>

- Chlorpyrifos damaged bees' brains at levels below what is commonly found in the field
- Chlorpyrifos damaged bees' memory and recall, which play a central role in bee behavior

National Marine Fisheries Service. Biological Opinion on the Environmental Protection Agency's Registration of Pesticides containing Chlorpyrifos, Diazinon, and Malathion. Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

- Adult and juvenile Atlantic sturgeon, which are listed as endangered, are at a high risk from exposure to chlorpyrifos
- Concentrations of the chemical can reduce their abundance and spawning productivity.