

PESTICIDES IN PARADISE: ANNOTATED BIBLIOGRAPHY

1. ACUTE ILLNESSES ASSOCIATED WITH PESTICIDE EXPOSURE AT SCHOOLS

Alarcon WA, Calvert GM, Blondell JM, Mehler LN, Sievert BS, Propeck M, Tibbetts DS, Becker A, Lackovic M, Soilea SB, Das R, Beckman J, Dorilee PM, Thomsen CL, Stanbury M

Journal of the American Medical Association (2005), 294(4): 455-465

- ❖ Pesticides continue to be used on school property, and some schools are at risk of pesticide drift exposure from neighboring farms, which leads to pesticide exposure among students and school employees. However, information on the magnitude of illnesses and risk factors associated with these pesticide exposures is not available. **Objective:** To estimate the magnitude of and associated risk factors for pesticide related illnesses at schools. **Design, Setting, and Participants:** Analysis of surveillance data from 1998 to 2002 of 2593 persons with acute pesticide-related illnesses associated with exposure at schools. Nationwide information on pesticide-related illnesses is routinely collected by 3 national pesticide surveillance systems: the National Institute for Occupational Safety and Health's Sentinel Event Notification System for Occupational Risks pesticides program, the California Department of Pesticide Regulation, and the Toxic Exposure Surveillance System. **Main Outcome Measures:** Incidence rates and severity of acute pesticide-related illnesses. **Results:** Incidence rates for 1998-2002 were 7.4 cases per million children and 27.3 cases per million school employee full-time equivalents. The incidence rates among children increased significantly from 1998 to 2002. Illness of high severity was found in 3 cases (0.1%), moderate severity in 275 cases (11%), and low severity in 2315 cases (89%). Most illnesses were associated with insecticides (n=895, 35%), disinfectants (n=830, 32%), repellents (n=335, 13%), or herbicides (n=279, 11%). Among 406 cases with detailed information on the source of pesticide exposure, 281 (69%) were associated with pesticides used at schools and 125 (31%) were associated with pesticide drift exposure from farmland. **Conclusions:** Pesticide exposure at schools produces acute illnesses among school employees and students. To prevent pesticide-related illnesses at schools, implementation of integrated pest management programs in schools, practices to reduce pesticide drift, and adoption of pesticide spray buffer zones around schools are recommended.

2. PESTICIDE EXPOSURE IN CHILDREN - POLICY STATEMENT

American Academy of Pediatrics (AAP)

Pediatrics 2012, 130(6): e1757-e1763

- ❖ This statement presents the position of the American Academy of Pediatrics on pesticides. Pesticides are a collective term for chemicals intended to kill unwanted insects, plants, molds, and rodents. Children encounter pesticides daily and have unique susceptibilities to their potential toxicity. Acute poisoning risks are clear, and understanding of chronic health implications from both acute and chronic exposure are emerging. Epidemiologic evidence demonstrates associations between early life exposure to pesticides and pediatric cancers, decreased cognitive function, and behavioral problems. Related animal toxicology studies provide supportive biological plausibility for these findings. Recognizing and reducing problematic exposures will require attention to current inadequacies in medical training, public health tracking, and regulatory action on pesticides. Ongoing research describing toxicologic vulnerabilities and exposure factors across the life span are needed to inform regulatory needs and appropriate interventions. Policies that promote integrated pest management, comprehensive pesticide labeling, and marketing practices that incorporate child health considerations will enhance safe use.

3. AN EXPLORATORY ANALYSIS OF THE EFFECT OF PESTICIDE EXPOSURE ON THE RISK OF SPONTANEOUS ABORTION IN AN ONTARIO FARM POPULATION

Arbuckle TE, Lin Z, Mery LS

Environmental Health Perspectives 2001, 109(8): 851-857

❖ The toxicity of pesticides on human reproduction is largely unknown—particularly how mixtures of pesticide products might affect fetal toxicity. The Ontario Farm Family Health Study collected data by questionnaire on the identity and timing of pesticide use on the farm, lifestyle factors, and a complete reproductive history from the farm operator and eligible couples living on the farm. A total of 2,110 women provided information on 3,936 pregnancies, including 395 spontaneous abortions. To explore critical windows of exposure and target sites for toxicity, we examined exposures separately for preconception (3 months before and up to month of conception) and postconception (first trimester) windows and for early (< 12 weeks) and late (12–19 weeks) spontaneous abortions. We observed moderate increases in risk of early abortions for preconception exposures to phenoxy acetic acid herbicides [odds ratio (OR) = 1.5; 95% confidence interval (CI), 1.1–2.1], triazines (OR = 1.4; 95% CI, 1.0–2.0), and any herbicide (OR = 1.4; 95% CI, 1.1–1.9). For late abortions, preconception exposure to glyphosate (OR = 1.7; 95% CI, 1.0–2.9), thiocarbamates (OR = 1.8; 95% CI, 1.1–3.0), and the miscellaneous class of pesticides (OR = 1.5; 95% CI, 1.0–2.4) was associated with elevated risks. Postconception exposures were generally associated with late spontaneous abortions. Older maternal age (> 34 years of age) was the strongest risk factor for spontaneous abortions, and we observed several interactions between pesticides in the older age group using Classification and Regression Tree analysis. This study shows that timing of exposure and restricting analyses to more homogeneous endpoints are important in characterizing the reproductive toxicity of pesticides.

4. PESTICIDE EXPOSURE AND DEPRESSION AMONG MALE PRIVATE PESTICIDE APPLICATORS IN THE AGRICULTURAL HEALTH STUDY

Beard JD, Umabach DM, Hoppin JA, Richards M, Alavanja MCR, Blair A, Sandler DP, Kamel F

Environmental Health Perspectives 2014, 122(9): 984-991.

❖ Pesticide exposure may be positively associated with depression. Few previous studies have considered the episodic nature of depression or examined individual pesticides. **Objective:** Researchers evaluated associations between pesticide exposure and depression among male private pesticide applicators in the Agricultural Health Study. **Methods:** Researchers analyzed data for 10 pesticide classes and 50 specific pesticides used by 21,208 applicators enrolled in 1993–1997 who completed a follow-up telephone interview in 2005–2010. Researchers divided applicators who reported a physician diagnosis of depression (n = 1,702; 8%) into those who reported a previous diagnosis of depression at enrollment but not follow-up (n = 474; 28%), at both enrollment and follow-up (n = 540; 32%), and at follow-up but not enrollment (n = 688; 40%) and used polytomous logistic regression to estimate odds ratios (ORs) and 95% CIs. Researchers used inverse probability weighting to adjust for potential confounders and to account for the exclusion of 3,315 applicators with missing covariate data and 24,619 who did not complete the follow-up interview. **Results:** After weighting for potential confounders, missing covariate data, and dropout, ever-use of two pesticide classes, fumigants and organochlorine insecticides, and seven individual pesticides—the fumigants aluminum phosphide and ethylene dibromide; the phenoxy herbicide (2,4,5-trichlorophenoxy) acetic acid (2,4,5-T); the organochlorine insecticide dieldrin; and the organophosphate insecticides diazinon, malathion, and parathion—were all positively associated with depression in each case group, with ORs between 1.1 and 1.9. **Conclusion:** This study supports a positive

association between pesticide exposure and depression, including associations with several specific pesticides.

5. IMPACTS OF GENETICALLY ENGINEERED CROPS ON PESTICIDE USE IN THE U.S. – THE FIRST SIXTEEN YEARS

Benbrook CM

Environmental Science Europe 2012, 24(24)

- ❖ Herbicide-resistant crop technology has led to a 239 million kilogram (527 million pound) increase in herbicide use in the United States between 1996 and 2011, while Bt crops have reduced insecticide applications by 56 million kilograms (123 million pounds). Overall, pesticide use increased by an estimated 183 million kgs (404 million pounds), or about 7%. Contrary to often-repeated claims that today's genetically-engineered crops have, and are reducing pesticide use, the spread of glyphosate resistant weeds in herbicide-resistant weed management systems has brought about substantial increases in the number and volume of herbicides applied. If new genetically engineered forms of corn and soybeans tolerant of 2,4-D are approved, the volume of 2,4-D sprayed could drive herbicide usage upward by another approximate 50%. The magnitude of increases in herbicide use on herbicide-resistant hectares has dwarfed the reduction in insecticide use on Bt crops over the past 16 years, and will continue to do so for the foreseeable future.

6. PRENATAL EXPOSURE TO ORGANOPHOSPHATE PESTICIDES AND IQ IN 7-YEAR-OLD CHILDREN

Bouchard MF, Chevrier J, Harley KG, Koqut K, Vedar M, Calderon N, Trujilo C, Johnson C, Bradman A, Barr DB, Eskanzi B

Environmental Health Perspectives 2011, 119(8): 1189-1195

- ❖ Organophosphate (OP) pesticides are neurotoxic at high doses. Few studies have examined whether chronic exposure at lower levels could adversely affect children's cognitive development. **Objective:** Researchers examined associations between prenatal and postnatal exposure to OP pesticides and cognitive abilities in school-age children. **Methods:** Researchers conducted a birth cohort study (Center for the Health Assessment of Mothers and Children of Salinas study) among predominantly Latino farmworker families from an agricultural community in California. Researchers assessed exposure to OP pesticides by measuring dialkyl phosphate (DAP) metabolites in urine collected during pregnancy and from children at 6 months and 1, 2, 3.5, and 5 years of age. Researchers administered the Wechsler Intelligence Scale for Children, 4th edition, to 329 children 7 years of age. Analyses were adjusted for maternal education and intelligence, Home Observation for Measurement of the Environment score, and language of cognitive assessment. **Results:** Urinary DAP concentrations measured during the first and second half of pregnancy had similar relations to cognitive scores, so researchers used the average of concentrations measured during pregnancy in further analyses. Averaged maternal DAP concentrations were associated with poorer scores for Working Memory, Processing Speed, Verbal Comprehension, Perceptual Reasoning, and Full-Scale intelligence quotient (IQ). Children in the highest quintile of maternal DAP concentrations had an average deficit of 7.0 IQ points compared with those in the lowest quintile. However, children's urinary DAP concentrations were not consistently associated with cognitive scores. **Conclusion:** Prenatal but not postnatal urinary DAP concentrations were associated with poorer intellectual development in 7-year-old children. Maternal urinary DAP concentrations in the present study were higher but nonetheless within the range of levels measured in the general U.S. population.

7. PARKINSON'S DISEASE AND RESIDENTIAL EXPOSURE TO MANEB AND PARAQUAT FROM AGRICULTURAL APPLICATIONS IN THE CENTRAL VALLEY OF CALIFORNIA

Costello S

American Journal of Epidemiology 2009, 169(8): 919-926

- ❖ Evidence from animal and cell models suggests that pesticides cause a neurodegenerative process leading to Parkinson's disease (PD). Human data are insufficient to support this claim for any specific pesticide, largely because of challenges in exposure assessment. The authors developed and validated an exposure assessment tool based on geographic information systems that integrated information from California Pesticide Use Reports and land-use maps to estimate historical exposure to agricultural pesticides in the residential environment. In 1998–2007, the authors enrolled 368 incident PD cases and 341 population controls from the Central Valley of California in a case-control study. They generated estimates for maneb and paraquat exposures incurred between 1974 and 1999. Exposure to both pesticides within 500 m of the home increased PD risk by 75% (95% confidence interval (CI): 1.13, 2.73). Persons aged 60 years at the time of diagnosis were at much higher risk when exposed to either maneb or paraquat alone (odds ratio $\frac{1}{4}$ 2.27, 95% CI: 0.91, 5.70) or to both pesticides in combination (odds ratio $\frac{1}{4}$ 4.17, 95% CI: 1.15, 15.16) in 1974–1989. This study provides evidence that exposure to a combination of maneb and paraquat increases PD risk, particularly in younger subjects and/or when exposure occurs at younger ages.

8. PESTICIDE USE IN U.S. AGRICULTURE: 21 SELECTED CROPS, 1960-2008

Economic Research Service - United States Department of Agriculture

Economic Information Bulletin No. 124, May 2014

- ❖ Pesticide use has changed considerably over the past five decades. Rapid growth characterized the first 20 years, ending in 1981. The total quantity of pesticides applied to the 21 crops analyzed grew from 196 million pounds of pesticide active ingredients in 1960 to 632 million pounds in 1981. Improvements in the types and modes of action of active ingredients applied along with small annual fluctuations resulted in a slight downward trend in pesticide use to 516 million pounds in 2008. These changes were driven by economic factors that determined crop and input prices and were influenced by pest pressures, environmental and weather conditions, crop acreages, agricultural practices (including adoption of genetically engineered crops), access to land-grant extension personnel and crop consultants, the cost-effectiveness of pesticides and other practices in protecting crop yields and quality, technological innovations in pest management systems/ practices, and environmental and health regulations. Emerging pest management policy issues include the development of glyphosate-resistant weed populations associated with the large increase in glyphosate use since the late 1990s, the development of Bt-resistant western corn rootworm in some areas, and the arrival of invasive or exotic pest species, such as soybean aphid and soybean rust, which can influence pesticide use patterns and the development of Integrated Pest Management programs.

9. ORGANOPHOSPHATE PESTICIDE EXPOSURE AND NEURODEVELOPMENT IN YOUNG MEXICAN-AMERICAN CHILDREN

Eskenazi B, Marks AR, Bradman A, Harley K, Barr DB, Johnson C, Morga N, Jewell NP

Environmental Health Perspectives 2007, 115(5): 792–798

- ❖ Organophosphate (OP) pesticides are widely used in agriculture and homes. Animal studies suggest that even moderate doses are neurodevelopmental toxicants, but there are few studies in humans. Objectives: Researchers investigated the relationship of prenatal and child OP urinary metabolite levels with children's neurodevelopment. Methods: Participating children were from a longitudinal birth cohort of primarily Latino farmworker families in California. Researchers measured six nonspecific dialkylphosphate (DAP) metabolites in maternal and child urine as well as metabolites specific to malathion (MDA) and chlorpyrifos (TCPy) in maternal urine. Researchers examined their association with children's performance at 6 (n = 396), 12 (n = 395), and 24 (n = 372) months of age on the Bayley Scales of Infant Development [Mental Development (MDI) and Psychomotor Development (PDI) Indices] and mother's report on the Child Behavior Checklist (CBCL) (n = 356). Results: Generally, pregnancy DAP levels were negatively associated with MDI, but child measures were positively associated. At 24 months of age, these associations reached statistical significance [per 10-fold increase in prenatal DAPs: $\beta = -3.5$ points; 95% confidence interval (CI), -6.6 to -0.5; child DAPs: $\beta = 2.4$ points; 95% CI, 0.5 to 4.2]. Neither prenatal nor child DAPs were associated with PDI or CBCL attention problems, but both prenatal and postnatal DAPs were associated with risk of pervasive developmental disorder [per 10-fold increase in prenatal DAPs: odds ratio (OR) = 2.3, p = 0.05; child DAPs OR = 1.7, p = 0.04]. MDA and TCPy were not associated with any outcome. Conclusions: Researchers report adverse associations of prenatal DAPs with mental development and pervasive developmental problems at 24 months of age. Results should be interpreted with caution given the observed positive relationship with postnatal DAPs.

10. PESTICIDES IN THE AIR – KIDS AT RISK: PETITION TO EPA TO PROTECT CHILDREN FROM PESTICIDE DRIFT

Goldman P, Brimmer JK, Ruiz V

Earth Justice and Farmworker Justice October 2009

- ❖ This petition asks the U.S. Environmental Protection Agency (EPA) to remedy ongoing violations of its legal obligations to protect children from unsafe aggregate exposures to pesticides. Specifically, EPA has failed to protect children from exposure to toxic pesticides that drift from agricultural fields and contaminate areas where children congregate, such as homes, park, schools, and daycare centers. To ensure that children are protected from toxic pesticides as required by the law, this petition asks EPA to: (1) expeditiously evaluate the exposure of children to pesticide drift and impose safeguards to ensure that children are protected from aggregate pesticide exposures, including pesticide drift; and (2) immediately adopt interim prohibitions on the use of toxic drift-prone pesticides such as organophosphates and n-methyl carbamates near homes, schools, parks, and daycare centers or wherever children congregate.

11. CARCINOGENICITY OF TETRACHLORVINPHOS, PARATHION, MALATHION, DIAZINON, AND GLYPHOSATE

Guyton KZ, Loomis D, Grosse Y, El Ghissassi F, Benbrahim-Tallaa L, Guha N, Scoccianti C, Mattock H, Straif K

Lancet Oncology 2015, (15):70134-70138

- ❖ In March, 2015, 17 experts from 11 countries met at the International Agency for Research on Cancer (IARC; Lyon, France) to assess the carcinogenicity of the organophosphate pesticides tetrachlorvinphos, parathion, malathion, diazinon, and glyphosate. Glyphosate has been detected in the blood and urine of agricultural workers, indicating absorption. Soil microbes degrade glyphosate to aminomethylphosphoric acid (AMPA). Blood AMPA detection after poisonings suggests intestinal microbial metabolism in

humans. Glyphosate and glyphosate formulations induced DNA and chromosomal damage in mammals, and in human and animal cells in vitro. One study reported increases in blood markers of chromosomal damage (micronuclei) in residents of several communities after spraying of glyphosate formulations.¹⁶ Bacterial mutagenesis tests were negative. Glyphosate, glyphosate formulations, and AMPA induced oxidative stress in rodents and in vitro. The Working Group classified glyphosate as “probably carcinogenic to humans” (Group 2A).

12. AGRICULTURE AND CANCER: A NEED FOR ACTION

Jacobs M, Clapp S (2008)

- ❖ Overall cancer incidence and mortality rates are low among farmers relative to the general population. However, studies of farming populations routinely reveal elevated risk for several specific types of cancer, including leukemia, non-Hodgkin’s lymphomas, multiple myeloma, soft-tissue sarcoma, and cancers of the skin, brain, prostate, stomach and lip. Researchers continue to explore whether there are a set of common exposures that may explain these higher incidence rates using epidemiologic studies. This work documents that a variety of substances either created by or used in agricultural practices may increase cancer risk, including: pesticides, nitrates in fertilizers, dusts, solvents, fuels, engine exhaust, paints and welding fumes. Although agricultural populations are exposed to a broad array of substances that have been linked to cancer, the bulk of the research to date has focused on pesticides. In 2001, an estimated 5 billion pounds of pesticides were used in the United States. Of that, 1.2 billion pounds were used primarily in the agricultural and home and garden sectors. Approximately 165 currently registered pesticidal chemicals (including active and inert ingredients in pesticides) have been classified by the Environmental Protection Agency (EPA) or the International Agency for Research on Cancer (IARC) as known, probable or possible human carcinogens. Yet only a small number of these chemicals have been severely restricted.

13. GLYPHOSATE PERSISTENCE IN SEAWATER

Mercurio P, Flores F, Mueller JF, Carter S, Negri AP

Marine Pollution Bulletin 2014, 85: 385-390

- ❖ Glyphosate is one of the most widely applied herbicides globally but its persistence in seawater has not been reported. Here researchers quantify the biodegradation of glyphosate using standard “simulation” flask tests with native bacterial populations and coastal seawater from the Great Barrier Reef. The half-life for glyphosate at 25 °C in low-light was 47 days, extending to 267 days in the dark at 25 °C and 315 days in the dark at 31 °C, which is the longest persistence reported for this herbicide. AMPA, the microbial transformation product of glyphosate, was detected under all conditions, confirming that degradation was mediated by the native microbial community. This study demonstrates glyphosate is moderately persistent in the marine water under low light conditions and is highly persistent in the dark. Little degradation would be expected during flood plumes in the tropics, which could potentially deliver dissolved and sediment bound glyphosate far from shore.

14. TECHNICAL REPORT - PESTICIDE EXPOSURE IN CHILDREN

Roberts JR, Karr CJ

Pediatrics 2012, 130(6): e1765-e1788

- ❖ Pesticides are a collective term for a wide array of chemicals intended to kill unwanted insects, plants, molds, and rodents. Food, water, and treatment in the home, yard, and school are all potential sources of children's exposure. Exposures to pesticides may be overt or subacute, and effects range from acute to chronic toxicity. In 2008, pesticides were the ninth most common substance reported to poison control centers, and approximately 45% of all reports of pesticide poisoning were for children. Organophosphate and carbamate poisoning are perhaps the most widely known acute poisoning syndromes, can be diagnosed by depressed red blood cell cholinesterase levels, and have available antidotal therapy. However, numerous other pesticides that may cause acute toxicity, such as pyrethroid and neonicotinoid insecticides, herbicides, fungicides, and rodenticides, also have specific toxic effects; recognition of these effects may help identify acute exposures. Evidence is increasingly emerging about chronic health implications from both acute and chronic exposure. A growing body of epidemiological evidence demonstrates associations between parental use of pesticides, particularly insecticides, with acute lymphocytic leukemia and brain tumors. Prenatal, household, and occupational exposures (maternal and paternal) appear to be the largest risks. Prospective cohort studies link early-life exposure to organophosphates and organochlorine pesticides (primarily DDT) with adverse effects on neurodevelopment and behavior. Among the findings associated with increased pesticide levels are poorer mental development by using the Bayley index and increased scores on measures assessing pervasive developmental disorder, inattention, and attention-deficit/hyperactivity disorder. Related animal toxicology studies provide supportive biological plausibility for these findings. Additional data suggest that there may also be an association between parental pesticide use and adverse birth outcomes including physical birth defects, low birth weight, and fetal death, although the data are less robust than for cancer and neurodevelopmental effects. Children's exposures to pesticides should be limited as much as possible.

15. MATERNAL RESIDENCE NEAR AGRICULTURAL PESTICIDE APPLICATIONS AND AUTISM SPECTRUM DISORDER AMONG CHILDREN IN THE CALIFORNIA CENTRAL VALLEY

Roberts EM, English PB, Grether JK, Windham GC, Somberg L, Wolf C

Environmental Health Perspectives 2007, 115(10): 1482-1489

- ❖ Ambient levels of pesticides ("pesticide drift") are detectable at residences near agricultural field sites. The researchers goal was to evaluate the hypothesis that maternal residence near agricultural pesticide applications during key periods of gestation could be associated with the development of autism spectrum disorders (ASD) in children. Researchers identified 465 children with ASD born during 1996–1998 using the California Department of Developmental Services electronic files, and matched them by maternal date of last menstrual period to 6,975 live-born, normal-birth-weight, term infants as controls. We determined proximity to pesticide applications using California Department of Pesticide Regulation records refined using Department of Water Resources land use polygons. A staged analytic design applying a priori criteria to the results of conditional logistic regressions was employed to exclude associations likely due to multiple testing error. Of 249 unique hypotheses, four that described organochlorine pesticide applications— specifically those of dicofol and endosulfan—occurring during the period immediately before and concurrent with central nervous system embryogenesis (clinical weeks 1 through 8) met a priori criteria and were unlikely to be a result of multiple testing. Multivariate a posteriori models comparing children of mothers living within 500 m of field sites with the highest nonzero quartile of organochlorine poundage to those with mothers not living near field sites suggested an odds ratio for ASD of 6.1 (95% confidence interval, 2.4–15.3). ASD risk increased with the poundage of organochlorine applied and decreased with distance from field sites. The association between residential proximity to organochlorine pesticide applications during gestation and ASD among children should be

16. LONG TERM TOXICITY OF ROUNDUP HERBICIDE AND A ROUNDUP-TOLERANT GENETICALLY MODIFIED MAIZE

Seralini GE, Clair E, Mesnage R, Gress S, Defarge N, Malatesta M, Hennequin D, de Vendomois JS

Environmental Science Europe 2014, 26(14)

- ❖ The health effects of a Roundup-tolerant genetically modified maize (from 11% in the diet), cultivated with or without Roundup, and Roundup alone (from 0.1 ppb in water), were studied 2 years in rats. In females, all treated groups died 2–3 times more than controls, and more rapidly. This difference was visible in 3 male groups fed GMOs. All results were hormone and sex dependent, and the pathological profiles were comparable. Females developed large mammary tumors almost always more often than and before controls, the pituitary was the second most disabled organ; the sex hormonal balance was modified by GMO and Roundup treatments. In treated males, liver congestions and necrosis were 2.5–5.5 times higher. This pathology was confirmed by optic and transmission electron microscopy. Marked and severe kidney nephropathies were also generally 1.3–2.3 greater. Males presented 4 times more large palpable tumors than controls which occurred up to 600 days earlier. Biochemistry data confirmed very significant kidney chronic deficiencies; for all treatments and both sexes, 76% of the altered parameters were kidney related. These results can be explained by the non linear endocrine-disrupting effects of Roundup, but also by the overexpression of the transgene in the GMO and its metabolic consequences.

17. NON-HODGKIN LYMPHOMA AND OCCUPATIONAL EXPOSURE TO AGRICULTURAL PESTICIDE CHEMICAL GROUPS AND ACTIVE INGREDIENTS: A SYSTEMATIC REVIEW AND META-ANALYSIS

Schinasi L, Leon ME

International Journal of Environmental Public Health (2014), 11(4): 4449-4527

- ❖ This paper describes results from a systematic review and a series of meta-analyses of nearly three decades worth of epidemiologic research on the relationship between non-Hodgkin lymphoma (NHL) and occupational exposure to agricultural pesticide active ingredients and chemical groups. Estimates of associations of NHL with 21 pesticide chemical groups and 80 active ingredients were extracted from 44 papers, all of which reported results from analyses of studies conducted in high-income countries. Random effects meta-analyses showed that phenoxy herbicides, carbamate insecticides, organophosphorus insecticides and the active ingredient lindane, an organochlorine insecticide, were positively associated with NHL. In a handful of papers, associations between pesticides and NHL subtypes were reported; B cell lymphoma was positively associated with phenoxy herbicides and the organophosphorus herbicide glyphosate. Diffuse large B-cell lymphoma was positively associated with phenoxy herbicide exposure. Despite compelling evidence that NHL is associated with certain chemicals, this review indicates the need for investigations of a larger variety of pesticides in more geographic areas, especially in low- and middle-income countries, which, despite producing a large portion of the world's agriculture, were missing in the literature that were reviewed.

18. NEURODEVELOPMENTAL DISORDERS AND PRENATAL RESIDENTIAL PROXIMITY TO AGRICULTURAL PESTICIDES: THE CHARGE STUDY

Shelton JF, Geraghty EM, Tancredi DJ, Delwiche LD, Schmidt RJ, Ritz B, Hansen RL, and Hertz-Picciotto I

Environmental Health Perspectives 2014, 122(10): 1103-1110

- ❖ Gestational exposure to several common agricultural pesticides can induce developmental neurotoxicity in humans, and has been associated with developmental delay and autism. **Objectives:** To evaluate whether residential proximity to agricultural pesticides during pregnancy is associated with autism spectrum disorders (ASD) or developmental delay (DD) in the Childhood Autism Risks from Genetics and Environment (CHARGE) Study. **Methods:** The CHARGE study is a population-based case-control study of ASD, developmental delay (DD), and typical development. For 970 participants, commercial pesticide application data from the California Pesticide Use Report (1997-2008) were linked to the addresses during pregnancy. Pounds of active ingredient applied for organophosphates, organochlorines, pyrethroids, and carbamates were aggregated within 1.25km, 1.5km, and 1.75km buffer distances from the home. Multinomial logistic regression was used to estimate the odds ratio (OR) of exposure comparing confirmed cases of ASD (n = 486) or DD (n = 168) with typically developing referents (n = 316). **Results:** Approximately one-third of CHARGE Study mothers lived, during pregnancy, within 1.5km (just under one mile) of an agricultural pesticide application. Proximity to organophosphates at some point during gestation was associated with a 60% increased risk for ASD, higher for 3rd trimester exposures [OR = 2.0, 95% confidence interval (CI) = (1.1, 3.6)], and 2nd trimester chlorpyrifos applications: OR = 3.3 [95% CI = (1.5, 7.4)]. Children of mothers residing near pyrethroid insecticide applications just prior to conception or during 3rd trimester were at greater risk for both ASD and DD, with OR's ranging from 1.7 to 2.3. Risk for DD was increased in those near carbamate applications, but no specific vulnerable period was identified. **Conclusion:** This study of ASD strengthens the evidence linking neurodevelopmental disorders with gestational pesticide exposures, and particularly, organophosphates and provides novel results of ASD and DD associations with, respectively, pyrethroids and carbamates.

19. AGRICULTURAL RESOURCE MANAGEMENT SURVEY: U.S. SOYBEAN INDUSTRY

USDA National Agricultural Statistics Service No. 2014-1, January 2014

- ❖ USDA's National Agricultural Statistics Service (NASS) and Economic Research Service (ERS) conducted the Agricultural Resource Management Survey (ARMS) of the U.S. soybean industry. During the summer and fall of 2012 and winter of 2013, trained enumerators conducted personal interviews with almost 2,500 soybean growers in the 19 largest soybean-producing states. The farmers provided information about their production practices, operating costs, and soybean production. This publication includes highlights of their production practices and resource use. One of the findings included increased herbicide use doubling for soybeans, when GE soybeans became dominantly used.



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