

# Wide Range of Diseases Linked to Pesticides

Database supports policy shift from risk to alternatives assessment

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The common diseases affecting the public's health are all too well-known in the 21st century: asthma, autism and learning disabilities, birth defects and reproductive dysfunction, diabetes, Parkinson's and Alzheimer's diseases, and several types of cancer. Their connection to pesticide exposure continues to strengthen despite efforts to restrict individual chemical exposure, or mitigate chemical risks, using risk assessment-based policy.

The *Pesticide-Induced Diseases Database*, launched by Beyond Pesticides, facilitates access to epidemiologic and laboratory studies based on real world exposure scenarios that link public health effects to pesticides. The scientific literature documents elevated rates of chronic diseases among people exposed to pesticides, with increasing numbers of studies associated with both specific illnesses and a range of illnesses. With some of these diseases at very high and, perhaps, epidemic proportions, there is an urgent need for public policy at all levels –local, state, and national—to end dependency on toxic pesticides, replacing them with carefully defined green strategies.

## Data Supports Policy Change

The database is a tool to support efforts to eliminate the continued use of hazardous pesticides in favor of green strategies that emphasize non-toxic and least-toxic alternative practices and products. The studies in the database show that our current approach to restricting pesticide use through risk assessment-based mitigation measures is not working. This failed human experiment must be ended. The warnings of those who have expressed concerns about risk assessment, such as EPA Administrator under Presidents Nixon and Reagan, William Ruckelshaus, have been borne out by three decades of use and study. Mr. Ruckelshaus in 1984 said, "We should remember that risk assessment data

can be like the captured spy: If you torture it long enough, it will tell you anything you want to know." EPA's risk assessment fails to look at chemical mixtures, synergistic effects, certain health endpoints (such as endocrine disruption), disproportionate effects to vulnerable population groups, and regular noncompliance with product label directions. These deficiencies contribute to its severe limitations in defining real world poisoning, as captured by epidemiologic studies in the database.

An enlightened policy approach to proposed or continued toxic chemical use, in an age where the adverse effects have been widely and increasingly documented, is to first ask whether there is a less toxic way of achieving the toxic chemical's intended purpose. Simply, "Is there another practice that would make the substance unnecessary?" This approach does not preclude and should demand the prohibition of high hazard chemical use, those chemicals that are simply too dangerous.

The alternatives assessment approach differs most dramatically from a risk assessment-based policy in rejecting uses and exposures deemed acceptable under risk assessment calculations, but unnecessary because of the availability of safer alternatives. For example, in agriculture, where the database shows clear links to pesticide use and cancer, it would no longer be possible to use hazardous pesticides, as it is with risk assessment-based policy, when there are clearly effective organic systems with competitive yields that, in fact, outperform chemical-intensive agriculture in drought years. Cost comparisons must take into account externalities such as water pollution and water utility expenses, associated with chemical-intensive farming. The same is true for home and garden pesticide use and defined integrated pest management systems with prescribed practices and only specific substances as a last resort.



The database suggests clearly that we must take strategic action to shift away from pesticide dependency. Public policy must advance this shift, rather than continue to allow unnecessary reliance on pesticides. Regulatory restrictions must be tied to alternatives assessment that move chemicals off the market or prohibit their marketing as safer approaches and technologies emerge.

## About the Database

In order to track the varying public health effects of pesticide exposure, Beyond Pesticides has established the *Pesticide-Induced Diseases Database*, which tracks diseases and other health issues linked to real world pesticide exposure, providing access to published studies and their findings. The database is housed on the Beyond Pesticides website at [www.beyondpesticides.org/health](http://www.beyondpesticides.org/health), as it requires periodic updating. The current database, which contains hundreds of studies, itself is preliminary and will be added to over the coming months. We urge readers to send studies to [info@beyondpesticides.org](mailto:info@beyondpesticides.org) that you think should be added to the database.

## Findings and Database Entries

### Alzheimer's Disease

According to the Alzheimer's Association, Alzheimer's disease

(AD), the most common form of dementia, is a progressive and fatal brain disease. As many as 5.3 million Americans are living with Alzheimer's disease. Alzheimer's destroys brain cells, causing memory loss and problems with thinking and behavior severe enough to affect work, lifelong hobbies or social life. Alzheimer's gets worse over time, it is fatal, and has no current cure.

**At publication, the database lists 4 studies linking pesticides to Alzheimer's disease.** While many studies link pesticides to neurological effects, research is just beginning to make the link between pesticides and AD. A recent study of individuals from an agricultural

community in Utah shows increased risks among pesticide-exposed individuals for all causes of dementia (hazard ratio, HR, 1.38) and an even greater risk for AD (HR 1.42). The risk of AD associated with organophosphate exposure is the greatest (HR 1.53) followed by organochlorines (HR 1.49).<sup>1</sup>

### Asthma

Since the mid-1980s, asthma rates in the U.S. have skyrocketed to epidemic levels, particularly in young children. In the U.S. alone, around 16 million people suffer from asthma. Asthma is a serious chronic disorder, and in some cases life-threatening disease, of the lungs characterized by recurrent attacks of bronchial constriction, which cause breathlessness, wheezing, and coughing. Researchers have found that pesticide exposure can induce a poisoning effect linked to asthma.

Low-income populations, people of color, and children living in inner cities experience disproportionately high morbidity and mortality due to asthma. According to the National Institutes of Health's National Institute of Allergy and Infectious Disease, African Americans are four to six times more likely than whites to die from asthma. Therefore, any time our policies allow regulators to permit uses of pesticides with known asthma effects, which is done daily, a disproportionate impact is felt in the African-American community. Among other policies, this toxics policy contributes

### Beyond Agricultural Pesticide Exposure

While agriculture has traditionally been tied to pesticide-related illnesses, of the 40 most commonly used pesticides in schools, 28 can cause cancer, 14 are linked to endocrine disruption, 26 can adversely affect reproduction, 26 are nervous system poisons and 13 can cause birth defects. Of the 30 most commonly used lawn pesticides, 19 can cause cancer, 13 are linked to birth defects, 21 can affect reproduction and 15 are nervous system toxicants. A number of published studies using animal toxicity data and human cells/tissue laboratory data also show that pesticides are linked to several major public health problems.

to a cycle of poverty, as asthma is the leading cause of school absenteeism due to chronic illness.

**At publication, the database lists 41 studies linking pesticides to asthma.** Studies show that pesticides not only trigger asthma attacks, but are also a root cause of asthma. A landmark 2004 study finds that not only do environmental exposures lead to above-average asthma rates among children, but that timing of exposure is also crucial. Examining over 4,000 school-aged children in California, the researchers discovered that children exposed to herbicides during their first year of life are four and a half times more likely to be diagnosed with asthma before the age of five; toddlers exposed to insecticides are over two times more likely to get asthma.<sup>2</sup>



### **Birth and Fetal Defects**

In 2005, the births of three babies born in Florida with severe birth defects to mothers who all worked for Ag-Mart Produce, a company that produces chemically-treated tomatoes and other agricultural products, brought the connection between birth defects and pesticide exposure into the public consciousness. Birth defects are structural or functional abnormalities present at birth that cause physical or mental disabilities, ranging from mild to fatal. Researchers have identified thousands of different types of birth defects. Currently, birth defects are the leading cause of death for infants during the first year of life.

**At publication, the database lists 19 studies linking pesticides to**

**fetal and birth defects.** A study published in the April 2009 issue of the medical journal *Acta Paediatrica* reports that the highest rates of birth defects for U.S. babies arise when conception occurs during the spring and summer months, when pesticide use increases and high concentrations of pesticides are found in surface waters. A strong association is found between higher rates of birth defects, including spina bifida, cleft lip, clubfoot and Down's syndrome, among women who conceive while nitrates, atrazine and other pesticides are at the high end of their seasonal fluctuations.<sup>3</sup>

### **Cancer**

The link between pesticides and cancer has long been a concern. While agriculture has traditionally been tied to pesticide-related illnesses, 19 of 30 commonly used lawn pesticides and 28 of 40 commonly used school pesticides are linked to cancer. Even with the growing body of evidence linking environmental exposures to cancer in recent years, a report released May 6, 2010 by the President's Cancer Panel finds that the true burden of environmentally-induced cancer is greatly underestimated. The Panel's report, *Reducing Environmental Cancer Risk: What We Can Do Now*, concludes that while environmental exposure is not a new front on the war on cancer, the grievous harm from carcinogenic chemical use has not been addressed adequately by the nation's cancer program.



**At publication, the database lists 260 studies linking pesticides to various forms of cancer** (see specific types of cancer below). While a number of published scientific studies using animal toxicity data and human cells/tissue laboratory studies show that pesticides are known or suspected to be carcinogenic, epidemiologic studies confirm laboratory results. The

review finds a significant association between cancer and pesticides used in agriculture and throughout the urban environment in homes, schools, and public places.

**Brain Cancer** – There are two main types of brain cancer. Primary brain cancer starts in the brain. Metastatic brain cancer starts somewhere else in the body and moves to the brain. According to the American Brain Tumor Association, brain tumors are the most common of the solid tumors in children, and the second most frequent malignancy of childhood. Brain tumors are the second leading cause of cancer-related deaths in males under 40 and the second leading cause of cancer-related deaths in females under age 20.



**At publication, the database lists 30 studies linking pesticides to brain cancer.** Researchers believe that insecticides that target the nervous system may play a role in the development of brain tumors. A population-based, case control study of children ten years of age or younger that analyzes functional genetic polymorphisms and parents' use of home insecticide treatments suggests that exposure in childhood to insecticides in combination with a reduced ability to detoxify them increases the risk of developing brain tumors. Several studies show adults with brain cancer are more likely to have been exposed to pesticides.<sup>4</sup>

**Breast Cancer** – Doctors estimate that one in eight women will be diagnosed with breast cancer in their lifetime. It is the leading cause of death in North America for women 35 to 50 years old. Genetics can only account for five to ten percent of cases. According to the Breast Cancer Fund, a growing body of scientific evidence suggests that exposures to toxic chemicals, including

pesticides, in the environment are contributing to high breast cancer rates.

**At publication, the database lists 11 studies linking pesticides to breast cancer.** Some pesticides are breast carcinogens and others act by disturbing or mimicking hormones in the body, which can lead to breast cancer. (See Endocrine Disruption section.) A 2006 Long Island Breast Cancer Study Project report demonstrates that self-reported lifetime use of residential pesticides is associated with an increase in risk for breast cancer. The increase is found for women who report the use of pesticides overall, specifically lawn and garden pesticides, and is particularly high for households with professional applications.<sup>5</sup>

**Leukemia** – Cancer of the blood-forming cells of bone marrow, leukemia is the most common childhood cancer, accounting for 33 percent of the incidence of all childhood cancer and causing

more deaths among children and adults under the age of 20 than any other cancer, yet strikes ten times as many adults as children. Several published studies show a "critical window of exposure" to pesticides, whether used in the home or from parental occupational exposure, that are associated with leukemia in children, showing an especially high risk correlation with pesticide exposure during the mother's pregnancy.

**At publication, the database lists 40 studies linking pesticides to leukemia.** Studies link leukemia to both residential and agricultural exposure to pesticides, for adults, children and *in utero*. One case-control study in California finds household pesticide use can nearly quadruple the



## Epidemiology: The Challenge of Finding Patterns of Harm

Despite evidence to the contrary, chemical industry critics of epidemiologic studies linking pesticides to major diseases argue that they are of limited value because of their reliance on records and study participants' memory, among other issues. In fact, the correlation of patterns of chemical use with an effect is difficult to establish in epidemiology and therefore may underestimate hazard effects. When a correlation is established it raises serious concern. The epidemiologic studies in the *Pesticide-Induced Diseases Database* show an overall pattern that links pesticide exposure to major diseases.

Inherent limitations, such as the following, only add to the power of these studies as patterns of diseases tied to pesticide exposure emerge: (i) categorizing farmers all together as a group based on just the job title and not exposure assessments, yet farmers can have diverse exposure patterns from one another; (ii) seasonal and migrant farmworkers are not usually aware of the pesticide(s) which have been used where they are working; (iii) grouping chemicals by classes, when diseases may not be restricted to a certain chemical family; (iv) small number of study subjects; (v) recall bias among study participants; and, (vi) a lack of detailed exposure verification.

risk of childhood leukemia (odds ratio, OR, 3.8) and that garden pesticides increase the risk to over six-fold (OR 6.5).<sup>6</sup> A retrospective cohort mortality study of aerial pesticide applicator pilots, finds a significantly elevated risk for leukemia (OR 3.35).<sup>7</sup>

**Lymphoma** – Cancers that originate in the lymph system are referred to as lymphomas and include Hodgkin's lymphoma (HL) and non-Hodgkin's lymphoma (NHL). Lymphomas are the most common type of blood cancer in the U.S. It is the 7th most common in adults and the 3rd most common cancer in children. The more common non-Hodgkin's lymphoma is a cancer of the immune system. The incidence of NHL has been increasing over the past several decades and has doubled since the early 1970s.

**At publication, the database lists 46 studies linking pesticides to lymphoma.** According to the Lymphoma Foundation of America, 75 out of all 99 epidemiologic studies conducted on lymphoma and pesticides find a link between the two. The report states that data from the National Cancer Institute show that people develop lymphoma often in states and locations with the highest pesticide use. The report finds that farmers are at the highest risk for lymphoma.<sup>8</sup>

Dozens of studies in the database confirm the risk to farmers and other pesticide applicators.

**Prostate Cancer** – Cancer of the prostate, a gland of the male reproductive system, is the second most common cancer among American men, with one in six men diagnosed during their lifetime. It is also the second leading cause of death for American men. Incidence and death trends show that prostate cancer has been slightly decreasing since 1994.

**At publication, the database lists 23 studies linking pesticides to prostate cancer.** Studies show elevated rates of prostate cancer in Vietnam veterans exposed to Agent Orange and to farmers and others with occupational pesticide exposure. A study published in 2003 in the *International Journal of Cancer* shows that individuals who have worked in agriculture have a 40% increased risk of having prostate cancer over the general population.<sup>9</sup> Other studies suggest that endocrine disruption is likely to be a mechanism for developing this type of cancer.

**Soft Tissue Sarcoma** Cancer that begins in the muscle, fat, fibrous tissue, blood vessels, or other supporting





tissue of the body, known as soft tissue sarcoma, is uncommon, yet risk is increased with exposure to certain chemicals, radiation therapy and certain genetic diseases.

**At publication, the database lists 7 studies linking pesticides to soft tissue sarcoma.** A 1995 case-control study of Denver children finds that yard pesticide applications are linked to a four-fold increase in risk to soft tissue sarcomas (OR 4.0).<sup>10</sup> Other studies associate living near agricultural areas with the disease.

**Other Cancers** – With so many pesticides on the market and possible combinations for exposure, there are scores of different types of cancers with scientific links to pesticides. As the President's Cancer Panel points out, "Approximately 40 chemicals classified by the International Agency for Research on Cancer (IARC) as known, probable, or possible human carcinogens, are used in EPA-registered pesticides now on the market."

**At publication, the database lists 105 studies linking pesticides to other types of cancers.** These include cancer of the bladder, bone, cervix, colon, eye, gallbladder, kidney/renal, larynx, lip, liver, lungs, mouth, esophagus, ovarian, pancreas, rectum, sinus/nasal, stomach, testicles and thyroid, as well as melanoma (a form of skin cancer), multiple myeloma (cancer of the plasma cells of bone marrow) and neuroblastoma (cancer of the nerve cells).

## **Developmental and Learning Disorders**

Roughly one in six children in the U.S. has one or more developmental disabilities, ranging from

a learning disability to a serious behavioral or emotional disorder. Scientists believe that the amount of toxic chemicals in the environment that cause developmental and neurological damage are contributing to the rise of physical and mental effects being found in children. Studies show children's developing organs create "early windows of great vulnerability" during which exposure to pesticides can cause great damage. In the U.S., requirements for testing pesticides and other chemicals for potential developmental and learning disorders are minimal.

A developing brain is much more susceptible to the toxic effects of chemicals than an adult brain. During development,

the brain undergoes a highly complex series of processes at different stages. Interference from toxic substances that disrupt these processes can have permanent consequences. That vulnerability extends from fetal development through infancy and childhood to adolescence. Research has shown that environmental toxicants, such as pesticides, at low levels of exposure can have subclinical effects—not clinically visible, but still important adverse effects, such as decreases in intelligence or changes in behavior.

**At publication, the database lists 26 studies linking pesticides to learning and developmental disorders.** These include general developmental delays, attention deficit hyperactivity disorder (ADHD) and autism. A 2009 study published in the journal *Pediatrics* links a mother's exposure to urban air pollutants known as polycyclic aromatic hydrocarbons (PAHs), which include pesticides, to a reduced intelligence quotient (IQ) in their children.<sup>11</sup>





**At publication, the database lists 8 studies linking pesticides to ADHD.** In one study linking ADHD to pesticide exposure, scientists from the University of Montreal and Harvard University examine data from the *National Health and Nutrition Examination Survey* (NHANES), a program of studies designed to assess the health and nutritional status of adults and children. The study shows that for children with a 10-fold increase in the concentration of dialkyl phosphate metabolites in their urine (an indicator of organophosphate exposure) the odds of ADHD increase by more than 50%. For the breakdown product dimethyl triphosphate, the odds of ADHD almost double in kids with above-average levels compared to those without detectable levels.<sup>12</sup>

**Attention Deficit Hyperactivity Disorder** – Attention Deficit Hyperactivity Disorder is a neurobehavioral developmental disorder that causes inattention, impulsivity, and hyperactivity. It is estimated that around two million children in the U.S. have ADHD.

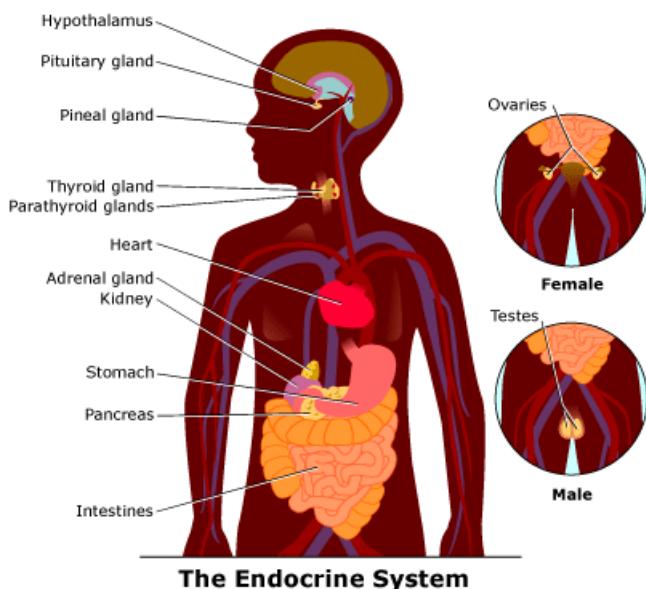
**Autism** – This complex developmental disorder, which is on the rise in both prevalence and incidence, includes behavioral problems with social interaction and communication. The symptoms range from mild to very severe, appearing before the age of three and lasting throughout a person's life. Research

## Endocrine Disruption

Common household products –detergents, disinfectants, plastics, and pesticides– contain chemical ingredients that enter the body, disrupt hormones and cause adverse developmental, disease, and reproductive problems. Known as endocrine disruptors, these chemicals, which interact with the endocrine system, wreak havoc in humans and wildlife. The endocrine system consists of a set of glands (thyroid, gonads, adrenal and pituitary) and the hormones they produce (thyroxine, estrogen, testosterone and adrenaline), which help guide the development, growth, reproduction, and behavior of animals, including humans. Hormones are signaling molecules, which travel through the bloodstream and elicit responses in other parts of the body.

Endocrine disruptors function by: (i) Mimicking the action of a naturally-produced hormone, such as estrogen or testosterone, thereby setting off similar chemical reactions in the body; (ii) Blocking hormone receptors in cells, thereby preventing the action of normal hormones; or (iii) Affecting the synthesis, transport, metabolism and excretion of hormones, thus altering the concentrations of natural hormones. Endocrine disruptors have been linked to attention deficit hyperactivity disorder (ADHD), Parkinson's and Alzheimer's diseases, diabetes, cardiovascular disease, obesity, early puberty, infertility and other reproductive disorders, and childhood and adult cancers.

More than 50 pesticide active ingredients have been identified as endocrine disruptors by the European Union and endocrine disruptor expert Theo Colborn, PhD. Endocrine disruption is the mechanism for several health effect endpoints. See the related sections (Cancer, Developmental and Learning Disorders, Parkinson's disease, Reproductive Health) for more information.





has shown that people with autism have certain irregularities in several regions of the brain and/or abnormal levels of serotonin or other neurotransmitters in the brain, suggesting that autism is associated with the disruption of normal brain development early in fetal development.

**At publication, the database lists 5 studies linking pesticides to autism.** A study published in the October 2007 issue of *Environmental Health Perspectives* shows that children born to mothers living near agricultural fields, where organochlorine pesticides, specifically endosulfan and dicofol, are applied during their first trimester of pregnancy, are six times more likely to have children that develop autism.<sup>13</sup>

### Diabetes

According to the American Diabetes Association, diabetes is a group of diseases characterized by high blood glucose levels that result from defects in the body's ability to produce and/or use insulin. Type 1 diabetes is usually diagnosed in children and young adults. In type 1 diabetes, the body does not produce insulin. Type 2 diabetes is the most common form of diabetes and is most common in communities of color and the aged population. In type 2 diabetes, either the body does not produce enough insulin or the cells ignore the insulin. Pesticides and other environmental factors are almost always linked to type 2 diabetes.

**At publication, the database lists 6 studies linking pesticides to diabetes.** Several studies show that pesticides and other pollutants can elevate the risk of type 2 diabetes by 20% to more than 100%. A study by the National Institutes of Health (NIH) finds pesticide applicators with regular exposure to pesticides

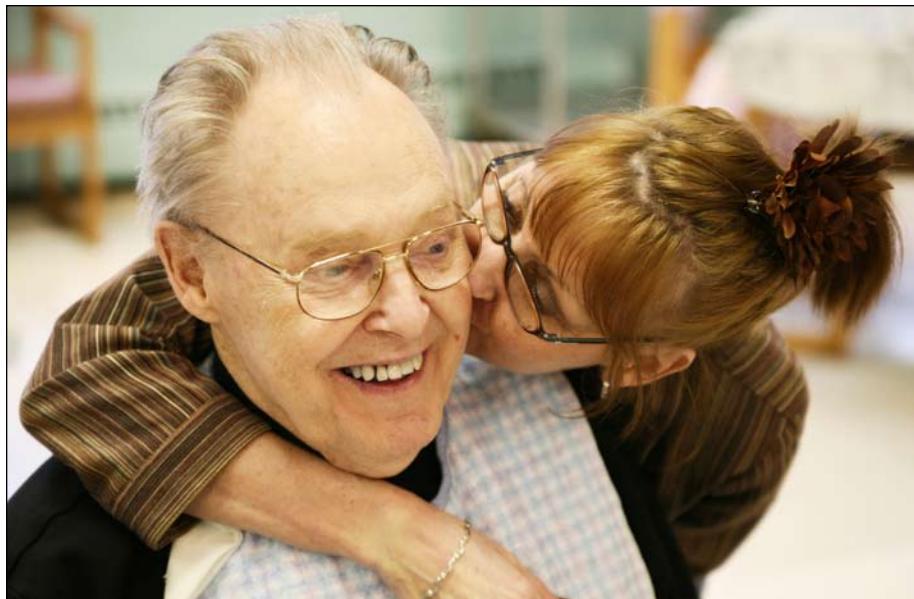
are at greater risk for type 2 diabetes. Applicators that had used certain insecticides more than 100 lifetime days nearly doubled their diabetes risk.<sup>14</sup>

### Parkinson's Disease

The second most common neurodegenerative disease, Parkinson's disease (PD) occurs when nerve cells in the *substantia nigra* region of the brain are damaged or destroyed and can no longer produce dopamine, a nerve-signaling molecule that helps control muscle movement. People with PD have a variety of symptoms including loss of muscle control, trembling and lack of coordination. They may also experience anxiety, constipation, dementia,

depression, urinary difficulties, and sleep disturbances. Over time, symptoms intensify. At least one million Americans have PD and about 50,000 new cases are diagnosed each year. With less than one percent of cases caused by genetics, researchers have been looking for the potential risk factors for developing Parkinson's disease (PD). The epidemiological and toxicological evidence is repeatedly identifying exposure to pesticides, as well as specific gene-pesticide interactions, as significant adverse risk factors that contribute to PD.

**At publication, the database lists 65 studies linking pesticides to Parkinson's disease.** In a review of 40 epidemiological case-control studies from 1983-2005 published in the journal *Environmental Health Perspectives*, researchers evaluated the relationship between PD and pesticide exposure, finding sufficient evidence that an association exists and is strongest for exposure to herbicides and insecticides, and after long durations of exposure.<sup>15</sup>



## **Reproductive Health Effects**

A robust body of literature details reproductive effects in fish, amphibians, and reptiles related to exposure to endocrine disruptors. Evidence of these effects has also been seen in wild mammals such as polar bears and seals. Environmental exposure assessments and wildlife, laboratory and epidemiologic studies show exposure to low-level environmental contaminants, such as pesticides and other chemicals, subtly undermines the ability to reproduce. The study of endocrine disruption is revealing mechanisms that show how specific environmental contaminants can alter fertility. Laboratory animal experiments have confirmed these wildlife findings.

***At publication, the database lists 22 studies linking pesticides to reproductive health effects.*** These include decreased fertility in both males and females, antiandrogenic (demasculinizing) effects, increased rates of miscarriage, altered sex ratios and altered maturity. A 2006 study published in the journal *Epidemiology* has found inverse associations between pesticides and male testosterone levels. The study found that high levels of the urinary metabolites of chlorpyrifos (TCPY) and carbaryl and naphthalene (1N) correlate directly with low levels of testosterone in male subjects.<sup>16</sup> A number of epidemiological studies and animal laboratory experiments that show strong associations or linkages between infertility rates and exposure to pesticides support the conclusions of this study.

**View Beyond Pesticides' full Pesticide-Induced Diseases Database at [www.beyondpesticides.org/health](http://www.beyondpesticides.org/health).**



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