

2,4-D Health Summary

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2,4-Dichlorophenoxyacetic acid (2,4-D) is an herbicide that was one of the two active ingredients in Agent Orange, the Vietnam War defoliant. Although the main health effects of Agent Orange were blamed on the other component of the mixture (2,4,5-T) and dioxin contamination, the data indicate that 2,4-D has significant health risks of its own. It remains unclear whether continuing low-level dioxin contamination of 2,4-D plays a role.

2,4-D and Lymphoma

Dozens of studies in humans have reported an association between exposure to 2,4-D and non-Hodgkin's lymphoma, a cancer of the white blood cells that can be fatal.¹ The first studies linking 2,4-D with non-Hodgkin's lymphoma were published in Sweden thirty years ago.² Some of these studies also found an association with soft-tissue sarcoma, a rare and frequently fatal cancer.³ More recently, studies published in Canada and Italy have supported these results, as have studies performed by researchers at the National Cancer Institute^{4,5,6} A recent study by the Dow Chemical Company of their pesticide production workers reported a 36 percent increase in non-Hodgkin's lymphoma in workers classified as exposed to 2,4-D, but the authors concluded the result was not statistically significant.⁷

2,4-D increases lymphocyte replication in humans. One study of pesticide applicators found increasing lymphocyte proliferation of 11 to 14 percent greater than normal in the applicators in a manner that was directly related to 2,4-D absorbed dose.⁸ This finding was confirmed in a follow-up study, showing a 12 to 15 percent increase in lymphocyte proliferation, with a further indication that higher-dose exposures may cause direct damage to white blood cells, thereby increasing the risk of lymphoid cancer in humans.⁹ This finding is consistent with the frequently-reported epidemiologic evidence linking 2,4-D exposure to non-Hodgkin's lymphoma in humans.

Many studies have found that 2,4-D formulations are cytotoxic (i.e., damage and kill cells) and mutagenic (i.e., trigger genetic mutations). For example, in human lymphocytes—commonly known as white blood cells—2,4-D causes chromosome breakage and aberrant cells.¹⁰ Lymphocytes are the cells that turn cancerous in lymphoma. Other studies have reported positive results in various other standardized tests of chromosome and DNA damage, including sister chromatid exchange in chick embryos and in the bone marrow and developing sperm cells of mice, and DNA damage in hamster ovary cells.^{11,12,13} In the aggregate, these studies demonstrate that 2,4-D can damage chromosomes and cause mutations in numerous cell types, which could explain why this chemical has been linked to cancer in humans.

In 2010, approximately 65,540 people in the United States were diagnosed with non-Hodgkin's lymphoma. The incidence of this disease in the United States has increased to about double the rate seen in the 1970s, even when adjusted for population size and age.¹⁴ It is reasonable to conclude, based on the

above information, that 2,4-D is likely responsible for some fraction of cases of non-Hodgkin's lymphoma each year.

2,4-D, Neuroendocrine Disruption, and Reproductive Effects

Dozens of peer-reviewed studies show that 2,4-D exhibits hormone-disrupting activity.^{15,16,17} 2,4-D also affects the function of the neurotransmitters dopamine and serotonin.¹⁸ Interference with hormones and neurotransmitters can cause serious and lasting effects during fetal and infant development, including birth defects, neurological damage in offspring, and interference with reproductive function such as suppression of sperm production.

Some human studies have been done on the hormonally-related effects of 2,4-D, and these support the results of the animal studies. Male farm sprayers exposed to 2,4-D have lower sperm counts and more spermatid abnormalities compared to men who are not exposed to this chemical.¹⁹ In Minnesota, higher rates of birth defects have been observed in wheat-growing areas of the state with the highest use of 2,4-D and other herbicides of the same class. This increase in birth defects was most pronounced among infants who were conceived in the spring, the time of greatest herbicide use.²⁰ A larger study in agricultural counties in Minnesota, Montana, North Dakota, and South Dakota found significant increases in birth malformations of the circulatory and respiratory systems, especially among infants conceived in April-June in wheat-growing counties (this is the time period and zone of greatest 2,4-D use).²¹ In the same study, infant deaths from birth defects among males were significantly elevated in high-wheat-growing counties. A recent epidemiological study found increased odds of Parkinson's disease in those with occupational exposure to 2,4-D.²²

Exposure to 2,4-D

2,4-D blows in the wind from the point of application, so the chemical may contaminate soil and water for many miles downwind. 2,4-D is classified by the EPA as a hazardous air pollutant and by the State of California as a toxic air contaminant. 2,4-D lingers in the soil for over a month after it is applied (the half-life of 2,4-D in soil is one week, with virtual elimination defined as about five half-lives).²³ Numerous studies have demonstrated that 2,4-D that was applied outdoors is commonly tracked into homes on shoes or pet paws, and that 2,4-D degrades very slowly when it is not exposed to direct outdoor sunlight, persisting for many months or even a year in household carpets.^{24, 25} Residues of 2,4-D on children's hands and in their urine have been shown to correlate closely with the levels of 2,4-D in carpet dust, demonstrating that the contamination from the dust enters children's bodies.²⁶

Studies in homes in Iowa within about a half-mile of agricultural fields where 2,4-D was applied detected the chemical in house dust in 95 percent of nearby homes.²⁷ 2,4-D has been found as a contaminant in surface water samples in the United States, and has also been detected in groundwater, according to the United States Geological Survey.²⁸ 2,4-D has also been detected in drinking water and it is a regulated contaminant in the National Primary Drinking Water Regulations.²⁹ Human exposure to 2,4-D is widespread, including among children. A 2008 study, for example, found 2,4-D in 83 percent of household dust samples in North Carolina and 98 percent of homes sampled in Ohio, despite the fact that only one homeowner in this study of 135 homes reported recent use of the pesticide.³⁰

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