

Asthma, Children and Pesticides

What you should know to protect your family



BEYOND PESTICIDES

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Since the mid-1980s, asthma rates in the United States have skyrocketed to epidemic levels, particularly in young children.¹ In the U.S. alone, around 16 million people suffer from asthma.² Asthma is a serious chronic disorder of the lungs characterized by recurrent attacks of bronchial constriction, which cause breathlessness, wheezing, and coughing. Asthma is a dangerous, and in some cases life-threatening disease. Researchers have found that pesticide exposure can induce a poisoning effect linked to asthma.

Children Are More Susceptible to Asthma

Asthma rates are much higher in children than adults. It is the most common long-term childhood illness. An estimated nine million children under the age of 18 have been diagnosed with asthma at some point in their lives.³

Did You Know?

- Nearly 1 in 8 school-aged children have asthma.⁴ This rate is rising most rapidly in pre-school aged children.⁵
- Asthma is the leading cause of school absenteeism due to chronic illness.⁶ Every year, asthma accounts for 14 million lost days of school.⁷
- Asthma is the third-ranking cause of hospitalization among those younger than 15 years of age.⁸
- The number of children dying from asthma increased almost threefold from 1979 to 1996.⁹
- The estimated cost of treating asthma in those younger than 18 years is \$3.2 billion per year.¹⁰
- Low-income populations, minorities, and children living in inner cities experience disproportionately high morbidity and mortality due to asthma.¹¹

Children are more susceptible to asthma for a number of reasons. The National Academy of Sciences has found that, in general, children are more vulnerable to toxic chemicals in the environment than adults.¹² This is because pound for pound, children eat more food and drink more water and juices than adults, and thus they take in more pesticides and toxic chemicals relative to body weight.¹³ Children also have a more rapid respiratory rate and take in a greater volume of air per unit of body weight than adults.¹⁴

At the same time, children's organ systems are still developing and therefore are more vulnerable and less able to detoxify hazardous chemicals.¹⁵ According to researchers at the Mount Sinai School of Medicine in New York City, children's developing organs create "early windows of great vulnerability" during which exposure to toxins can cause great damage.¹⁶ For example, human lungs and airways do not fully develop until the sixth to eighth year of life,¹⁷ making a young child vulnerable to the effects of pesticides and other pollutants on the respiratory system.¹⁸ During these early years, exposure to chemical irritants can have significant effects on respiratory development.¹⁹

"Epidemiologic studies suggest that children with asthma may breathe easier if they are exposed to fewer pesticides at home and at school. And parents and school administrators may breathe easier knowing that they are not harming the children's developing nervous systems."

-Dr. Ruth Etzel, MD, PhD, George Washington University School of Public Health and Health Services.

Environmental exposures during pregnancy may also be significant for children later in life. Researchers find that fetuses can become sensitized to environmental contaminants while still in the womb, resulting in a child being born with a predisposition to asthma and allergies.²⁰

Pesticides Can Cause Asthma

Determining the causes of a disease as common as asthma is no easy task, especially since there are so many factors to consider and so many potential pollutants that people are exposed to on a daily basis. Asthma has both genetic and environmental components. Certain people are genetically predisposed to asthma and allergies. However, the rapid increase in asthma rates in recent years cannot be explained by genetic causes alone, as genetic changes require many generations for population-wide effects to occur, and because asthma rates are increasing among people without a family history of asthma and allergies.²¹ There

is clearly a significant environmental component to the rise in the asthma rate.

Cause vs. Trigger

A good way to understand why people get asthma and sudden asthma attacks is to think in terms of causes and triggers. A cause is an underlying reason why a person gets asthma or other diseases. The exact causes of asthma are unknown, but experts have shown that exposure to cigarette smoke, air pollution, and allergens can cause increased levels of asthma in populations. A *trigger*, on the other hand, is something that causes an asthma attack to occur in someone already suffering from the disease. There are many known triggers of asthma attacks, including cigarette smoke, wood smoke, perfume, air pollution, pet dander, and allergens from dust mites and cockroaches. **Like cigarette smoke, pesticides have been shown to both cause asthma and trigger asthma attacks.**

Although no single study can conclusively prove that a certain pesticide causes asthma, studies have found evidence that exposure to pesticides is correlated with higher rates of asthma. One research focus has been on farmers and pesticide applicators, groups that are exposed to higher levels of pesticides than the average population. Studies have shown that this population has higher rates of asthma and other respiratory problems due to their use of pesticides.²² Yet occupational pesticide exposure is only one piece of the puzzle—household and community exposure to pesticides can also lead to respiratory problems. An early study done in the 1960s in Hawaii found that frequent household use of insecticides is correlated with an increased prevalence of respiratory disorders, including asthma and chronic bronchitis. The majority of the pesticides used were insect sprays for mosquitoes, flies, and cockroaches.²³

A 2003 study of over 3,000 Lebanese children similarly found correlations between exposures to pesticides and respiratory diseases.²⁴ Pesticide exposure includes home and garden pesticide use, occupational use by a household

member, and living in proximity to a treated field. All of these exposures are associated with chronic respiratory disease and symptoms, and particularly with asthma. The researchers hypothesize that exposure to pesticides (which are often small, irritating molecules) aggravates the airways of those with hypersensitized lungs (such as people with asthma). In children without previous respiratory problems, pesticides may overwhelm the cells' ability to detoxify chemicals, or cause immune and muscular effects, all of which can lead to respiratory problems.²⁵

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.²⁶ The researchers examined over 4000 school-aged children in California. They 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. This study further clarifies the fact that young infants and toddlers are most susceptible to the harmful effects of pesticides on the respiratory system.²⁷

“Studies have shown that early life is crucial for the development of the immune and the respiratory systems. Our data suggest that pesticide exposure during early childhood increases asthma risk by age 5, with exposures in the first year of life having the greatest impact on childhood asthma occurrence and its persistence in school-aged children.”

- Mohammed Towhid Salam, MD, University of Southern California, Department of Preventive Medicine, Los Angeles, CA.

Pesticides Can Trigger Asthma Attacks

In addition to being an underlying cause of asthma, pesticides can also trigger asthma attacks in those who already suffer from the disease. Asthma is characterized by excessive sensitivity of the lungs to various stimuli, which can trigger asthma attacks, also called asthma episodes.²⁸ The American Lung Association defines an asthma episode as “a series of events that result in narrowed airways” which lead to breathing problems and the characteristic asthma “wheeze.”²⁹ The series of events includes swelling of the lining, tightening of the muscle, and increased secretion of mucus.³⁰ Asthma attacks are triggered by a number of things, including allergens, irritants, pesticides and other chemicals, air pollution, and vigorous exercise.

People with asthma are especially sensitive to pesticides and at risk of attacks when exposed to even small amounts. Many pesticides are small molecules that can exacerbate or aggravate asthma symptoms.³¹ Pesticides can trigger asthma attacks by increasing airway hyper-reactivity, which makes the airway very sensitive to any allergen or other stimulus. Hypersensitive lungs are a trademark feature of asthmatics. Subsequent exposure to a stimulus can cause an extreme reaction in a hyper-reactive airway.³² In these situations, researchers at the Johns Hopkins Bloomberg School of Public Health have shown that pesticides somehow alter the nerve function controlling the smooth muscle lining of the airway, causing the airway to contract and restrain airflow, which is exactly what occurs during an asthma attack.³³ Pesticides can also trigger asthma attacks by directly damaging cells that line the lungs.³⁴

Specific Pesticides Linked to Respiratory Problems

Not all pesticides are associated with asthma, but many are. Of 30 commonly used lawn pesticides, 27 are sensitizers or irritants, and therefore have the potential to trigger asthma attacks, exacerbate asthma, or lead to a higher risk of developing asthma. Similarly, 39 of the 48 pesticides commonly used in schools may also contribute to asthma. The following is a list of some commonly used pesticides and how they contribute to asthma:

Herbicides

- **Glyphosate (Round-up®):** Glyphosate is one of the most commonly used pesticides on lawns and landscapes.³⁵ Exposure to glyphosate can cause asthma-like symptoms and breathing difficulty.³⁶ Undisclosed, or proprietary, ingredients (called “inert ingredients”) in Round-up®, a common formulation of glyphosate, have been linked to pneumonia and damage to the mucous membrane tissue and the upper respiratory tract.³⁷
- **2,4-D and Chlorophenoxy Herbicides:** 2,4-D, a lawn herbicide commonly formulated in “weed and feed” products, is the most commonly used “home and garden” pesticide in the U.S.³⁸ Chlorophenoxy compounds such as 2,4-D are moderately irritating to respiratory linings.³⁹ For people with asthma, exposure should be avoided, as it may aggravate the condition and trigger an asthma attack.⁴⁰ 2,4-D products are often formulated with the herbicides mecoprop and dicamba,

which are also respiratory irritants.⁴¹ These products often contain the warning, “Inhalation of product may aggravate existing chronic respiratory problems such as asthma, emphysema or bronchitis.”⁴²

- **Atrazine:** Atrazine is used on lawns, landscapes, golf courses, and agriculture. Use of atrazine by a large group of pesticide applicators is correlated with wheezing.⁴³ In addition, exposure to atrazine may cause an increased breathing rate and lung congestion.⁴⁴

The Cockroach Conundrum

Cockroach antigens can trigger asthma attacks in susceptible children.⁴⁵ A study of 476 asthmatic children from eight U.S. cities found that 85% of their bedrooms have cockroach allergens.⁴⁶ When people learn that cockroaches cause asthma, their first response may be to use pesticides. However, pesticides are even more closely linked to asthma and may only make conditions worse. A University of Southern California study finds the link between herbicides and the risk of developing asthma twice as strong as the link to cockroaches.⁴⁷

Tips For Preventing Cockroaches and Asthma

- Remove all food waste and keep food in airtight containers.
- Limit the spread of food around the house.
- Eliminate potential water sources, such as leaky plumbing.
- Caulk and seal all cracks and crevices.
- Vacuum frequently and vigorously.
- Monitor populations using sticky-traps.
- In the event of infestation, use boric acid bait stations.

Insecticides:

- **Pyrethrum and Pyrethrins:** Pyrethrum and pyrethrins are insecticides made from crude plant extracts in the chrysanthemum family.⁴⁸ These extracts contain impurities, which can be allergenic or otherwise irritating.⁴⁹ Pyrethrum has been known since the 1930s to cause allergies, asthma, and respiratory irritation.⁵⁰ Pyrethrins are more purified versions of these extracts that still contain small amounts of impurities that may cause asthmatic reactions and sensitization in individuals exposed.⁵¹ Pyrethrum and pyrethrin products are typically formulated with piperonyl butoxide (PBO), a synergist that reduces the ability of both insects and humans to detoxify pesticides. Inhaling PBO can cause labored breathing and an accumulation of fluids in the lungs, and is also linked to cancer.⁵²
- **Synthetic pyrethroids (Permethrin, Cypermethrin, Cyfluthrin, Sumithrin, Resmethrin):** Synthetic pyrethroids are chemically formulated versions of pyrethrum, which are designed to be more toxic and longer lasting. They are a heavily used class of insecticides used for control of cockroaches, termites, mosquitoes, fleas, and scabies. Exposure to synthetic pyrethroids can cause hypersensitization.⁵³ Safety data sheets often warn that, “[P]ersons with a history of asthma, emphysema, or hyperactive airways disease may be more susceptible to overexposure.”⁵⁴ Synthetic pyrethroids are usually formulated with PBO.
- **Organophosphates (Chlorpyrifos, Diazinon, Malathion, Methyl Parathion):** Organophosphates (OP) are a widely used class of pesticides, applied in houses for termite control, in communities for mosquito spraying, and in agriculture and on golf courses. OPs are neurotoxic and exposure can cause weakness of the respiratory muscles, broncho-constriction, bronchial secretions, wheezing, and general respiratory distress.⁵⁵ Children are especially vulnerable to their effects, and

reactions can occur at very low concentrations.⁵⁶ Exposure to OPs causes both short and long-term respiratory effects.⁵⁷

- **Carbamates (Carbaryl, Bendiocarb, Aldicarb, Carbofuran):** Carbamates are a class of insecticides that are also widely used in homes, gardens, and agriculture. Carbaryl (Sevin) is the most common. A study on hazardous air pollutants shows that carbaryl is “a compound that evokes asthma symptoms and has documented case reports in the medical literature associating exposure with asthma.”⁵⁸ Like OPs, carbamates also cause respiratory problems.⁵⁹

Fungicides

- **Fungicides:** A number of different fungicides have been shown to cause cases of occupational asthma among workers, including the fungicides chlorothalonil, fluazinam, and captafol.⁶⁰ Fungicides caused hypersensitivity in the workers, resulting in their airways to be highly sensitive and reactive to the inhaled fungicides, wheezing and breathlessness.

The Dust Mite Dilemma

Dust mites are microscopic insects (and powerful allergens) that live in bedrooms, carpets and furniture and feed off of dead human skin, a major component of household dust.⁶¹ A study of 476 children with asthma from eight U.S. cities finds that around 50% of their bedrooms are positive for dust mites.⁶² Reducing dust mites in the home has been shown to decrease the severity of respiratory symptoms in people with asthma.⁶³

Tips for Limiting Exposure to Dust Mites:

- Cover mattresses and pillows with encasings that are impermeable to mite allergens, but not to air and water vapor, often labeled “anti-allergenic.”⁶⁴
- Beddings should be washed frequently in hot water (at least 131 degrees).⁶⁵ Using eucalyptus oil while washing clothing and bedding may also help to kill mites.
- Vacuum frequently and vigorously.
- Reduce indoor humidity to under 45%.⁶⁶

Demographics of Asthma

The levels of asthma prevalence vary across regions of the U.S. On average, 12.5% of U.S. children have experienced asthma, and 7% have been diagnosed by a doctor or nurse. In Harlem, New York City, 28.5% have been diagnosed.⁶⁷ Trends show that people, especially children, living in urban, inner-city neighborhoods are affected the most by asthma.

Although rural and agricultural areas are assumed to have the highest levels of pesticide use, this is not always the case. A 1998 study found that in New York, the heaviest use of pesticides is in the most urban counties—Manhattan and Brooklyn.⁶⁸ Urban areas have higher asthma rates for a number of reasons, including higher levels of air pollution, both indoor and outdoor, heavy traffic dust and fumes, indoor pests, and higher levels of pesticide use. Children who live in poverty in inner-cities at the highest risk, as they often live in crowded, inadequate housing where poor conditions lead to at high risk of both exposure to cockroaches and other pests as well as to toxic pesticides.⁶⁹ Additionally, most housing projects are routinely sprayed with insecticides.⁷⁰

In addition to being elevated in urban areas, asthma rates are also disproportionately high among people-of-color, especially in African-American and Latino communities.⁷¹ Studies show that African-American

asthma-related hospitalization rates are four times higher and asthma death rates are double that of whites.⁷² Geography also accounts for variations in asthma rates. In 2004, the Allergy and Asthma Foundation of America developed a list of top “asthma capitals” based on prevalence, mortality rates, air quality, smoking laws, and asthma medical care. Knoxville, Tennessee, was number one, followed by Little Rock, AR and St. Louis, MO.

“Given the potential harm that pesticides can cause, it is worth trying to keep exposure to a minimum. There are ways to do that. Integrated pest management (IPM) is effective in reducing infestation with cockroaches and rodents in city homes. The methods of IPM include using non-toxic traps and eliminating sites of entry and food sources for pests.”

-Luz Claudio, PhD, Mount Sinai School of Medicine, Department of Community and Preventative Medicine, New York, NY

What You Can Do

Asthma is a serious epidemic that is not going to disappear on its own. Parents with young children, whether they have asthma or not, should limit their exposures to pesticides in the home, school, and community. This is especially imperative for people who have been diagnosed with asthma and other respiratory problems. There are easy steps that anyone can take to avoid known asthma causes and triggers, including pesticides, and reduce the risk of getting asthma.

- **Home:** According to EPA, around 85% of total daily exposure to airborne pesticides comes from breathing air inside the home.⁷³ Avoid applying any pesticides indoors, as well as on your lawn and in the garden.⁷⁴ If you have a pest problem, try preventative measures and non-toxic controls. Reducing indoor allergens and poisons can reduce the cost and severity of asthma treatments, and reduce the risk of developing new sensitizations and allergic reactions.⁷⁵ If you have a house pet, when controlling fleas, avoid insecticide sprays and shampoos.
- **Schools:** Children spend an average of 30 hours a week—more than 25 percent of their waking hours—at school.⁷⁶ A 2005 study published in the Journal of the American Medical Association documents widespread pesticide use and poisoning in schools—classrooms, cafeterias, playgrounds, playing fields, and school lawns.⁷⁷ In order to protect children’s health, schools should adopt non-toxic management methods. If pesticides are used, request that you be notified before they are applied on schools grounds. Students suffering from asthma triggered by pesticides or uncontrolled pest populations may be able to use the Americans With Disabilities Act (ADA) to require school to provide non-toxic, effective pest management.⁷⁸
- **Office Building:** Children are not the only ones affected by asthma. Adults spend most of their time in office buildings, and surveys indicate that on average, 40-55% of office occupants experience “sick building symptoms” which include headache, cough, wheezing, and fatigue on a weekly basis.⁷⁹ Talk to your employer about adopting an integrated pest management program that relies on non-toxic practices. A case under ADA may apply to this situation as well.⁸⁰
- **Public Housing:** Because of frequent pest problems, public housing buildings are often sprayed routinely with harmful pesticides. In 2003, 11 states petitioned the U.S. Department of Housing and Urban Development (HUD) to improve pest management in public housing by using non-chemical controls and integrated pest management. Cooperation and communication between public housing

management staff, maintenance staff, and tenants is necessary to reduce levels of pests and pesticides and create healthy living situations.

- **For more information on alternatives:** Because viable alternatives exist, taking a chance with toxic pesticides is never necessary. For more detailed information on alternative management strategies, or a full-color brochure of article, contact Beyond Pesticides at 202-543-5450 or visit www.beyondpesticides.org/children/asthma.

Beyond Pesticides, working with allies to protect public health and the environment, is leading the transition to a world free of toxic pesticides. The organization is a national, community-based collection of grassroots groups and individuals, bridging environmental and health concerns to: (i) stimulate widespread education on the hazards of toxic pesticides, and the availability of effective alternative pest management approaches; (ii) influence decision makers responsible for pest management to use safe methods through grassroots actions; and, (iii) encourage the adoption of local, state, and national policies that stringently restrict pesticide use and promote alternative approaches that respect health and the environment.



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Citations:

¹ Matthews, DD, ed. 2003. *Environmental Health Sourcebook*, 2nd ed. Detroit: Omnigraphics.

² Centers for Disease Control and Prevention. Feb 27 2004. Asthma Prevalence and Control Characteristics by Race/Ethnicity—United States, 2002. *Morbidity and Mortality Weekly Report*. 53 (7).

³ Centers for Disease Control and Prevention. March 2005. Summary Health Statistics for U.S. Children: National Health Interview Survey, 2003. *Vital and Health Statistics* 10 (223).

⁴ Centers for Disease Control and Prevention. March 2005.

⁵ Matthews, DD, ed. 2003. *Environmental Health Sourcebook*, 2nd ed. Detroit: Omnigraphics.

⁶ Ibid. (Matthews).

⁷ Centers for Disease Control and Prevention, National Center for Environmental Health August 2005. *Asthma's Impact on Children and Adolescents..* [Hhttp://www.cdc.gov/asthma/children.htm](http://www.cdc.gov/asthma/children.htm)H (Accessed August 2005)

⁸ Ibid. (CDC).

⁹ Ibid. (CDC).

¹⁰ Ibid. (CDC).

¹¹ Ibid. (CDC).

¹² National Research Council, National Academy of Sciences. 1993. *Pesticides in the Diets of Infants and Children*, Washington, DC: National Academy Press, 184-185.

¹³ Ibid.

¹⁴ Solomon G, J Kirsch, and OA Ogunseitan. 2000. *Pesticides and Human Health: A Resource for Health Care Professionals*. Washington, DC: Physicians for Social Responsibility and Californians for Pesticide Reform.

¹⁵ US EPA, Office of the Administrator. September 1996. *Environmental Health Threats to Children*. Washington, DC: 175-F-96-001.

¹⁶ Landrigan, PJ, L Claudio, SB Markowitz, et al. 1999. Pesticides and inner-city children: exposures, risks, and prevention. *Environmental Health Perspectives* 107 (Suppl 3): 431-437.

-
- ¹⁷ Burri PH. 1997. Postnatal development and growth. *The Lung: Scientific Foundations*, vol 1. (Crystal RG, West JB, Weibel ER, Barnes PJ, eds). Philadelphia, PA: Lippincott-Raven Publishers, 1013-1026.
- ¹⁸ Solomon, G, J Kirsch, and OA Ogunseitan. 2000. *Pesticides and Human Health: A Resource for Health Care Professionals*. Washington, DC: Physicians for Social Responsibility and Californians for Pesticide Reform.
- ¹⁹ Plopper, CG, and MV Fanucci. 2000. Do urban environmental pollutants exacerbate childhood lung diseases? *Environmental Health Perspectives* 108: A252-A253.
- ²⁰ Miller, RL, GL Chew, CA Bell, et al. 2001. Prenatal exposure, maternal sensitization, and sensitization *in utero* to indoor allergens in an inner-city cohort. *Am J Respir Crit Care Med* 164: 995-1001.
- ²¹ Solomon, G., and EH Humphreys, and MD Miller. August 15 2004. Asthma and the environment: Connecting the dots. *Contemporary Pediatrics* 21: 73; Christie GL, McDougall CM, Helms PJ. 1998. Is the increase in asthma prevalence occurring in children without a family history of atopy? *Scott Med J.* 43 (6): 180-182.
- ²² Senthilselvan, A, HH McDuffie, and JA Dosman. 1992. Association of asthma with use of pesticides. Results of a cross-sectional survey of farmers. *Am Rev Respir Dis.* 146 (4): 884-7; Royce, S, P Wald, D Sheppard, and J Balmes. 1993. Occupational asthma in a pesticides manufacturing worker. *Chest* 103: 295-296; Hoppin JA, DM Umbach, SH London, et al. 2002. Chemical predictors of wheeze among farmer pesticide applicators in the agricultural health study. *Am J Respir Crit Care Med* 165: 683-689; Solomon, et al, 2000. (Ref. #10).
- ²³ Weiner, BP, and RM Worth. 1969. Insecticides: Household use and respiratory impairment. *Hawaii Medical Journal* 28 (4): 283-285.
- ²⁴ Salameh, PR, I Baldi, P Brochard, et al. 2003. Respiratory symptoms in children and exposure to pesticides. *European Respiratory Journal* 22: 507-512.
- ²⁵ Ibid. (Salameh).
- ²⁶ Salam, MT, YF Li, B Langholz, and FD Gilliland. May 2004. Early-life environmental risk factors for asthma: Findings from the children's health study. *Environmental Health Perspectives* 112 (6): 760-765.
- ²⁷ Ibid. (Salam).
- ²⁸ American Lung Association. June 2004. *Asthma and Children Fact Sheet*. H<http://www.lungusa.org> (Accessed June 2004)
- ²⁹ Ibid. (American Lung).
- ³⁰ Ibid. (American Lung).
- ³¹ Salameh, PR et al, 2003. (Ref. #24)
- ³² Field, M. 2002. Asthma the Breathtaking Disease. The Magazine of Johns Hopkins Bloomberg School Of Public Health. Hhttp://www.jhsph.edu/publichealthnews/Mag_Fall02/Asthma.html (Accessed August 2005).
- ³³ Ibid. (Field).
- ³⁴ Mushak, EW and WT Piver. 1992. Agricultural Chemical Utilization and Human Health. *Environmental Health Perspectives* 97: 269-74.
- ³⁵ U.S. EPA. 2004. Pesticide Industry Sales and Usage Data. H<http://www.epa.gov/oppbead1/pestsales/index.htm> (Accessed August 2005).
- ³⁶ Cox, C. 2004. Glyphosate. *Journal of Pesticide Reform* 24 (4): 10-15.
- ³⁷ Sawada, YY, M Nagai, M Ueyama, and I Yamamoto. 1988. Probable toxicity of surface-active agent in commercial herbicide containing glyphosate. *Lancet* 1 (8580): 229. Cited in Mendelson, J. Sept/Oct 1998. Roundup: The World's Biggest-Selling Herbicide. *The Ecologist* 28 (5).
- ³⁸ U.S. EPA. 2004 (Ref. #35).
- ³⁹ Reigart, JR, and JR Roberts. 1999. Recognition and Management of Pesticide Poisonings, 5th edition. Washington, DC: US EPA, page 94.
- ⁴⁰ Infoventures, 1995. 2,4-D Pesticide Factsheet. <http://infoventures.com/e-hlth/pesticide/24d.html>.
- ⁴¹ Reigart and Roberts, 1999 (Ref. #39); Gosselin, RE, RP Smith, and HC Hodge. 1984. *Clinical Toxicology of Commercial Products*, 5th edition. Baltimore: Williams and Wilkins.
- ⁴² Riverdale. March 30 2005. Triplet SF Selective Herbicide Material Safety Data Sheet. MSDS #264. H<http://www.montereychemical.com/msds/Triplet-m.pdf> (Accessed August 2005).
- ⁴³ Hoppin, JA, DM Umbach, SJ London, et al. 2002. Chemical predictors of wheeze among farmer pesticide applicators in the agricultural health study. *M J Respir Crit Care Med* 165: 683-689.
- ⁴⁴ Gosselin, 1984 (Ref. #41).
- ⁴⁵ Roberts, J. 1996. Cockroaches linked with asthma. *BMJ* 312:1630; Liccardi, G, A Custovic, M Cazzola, et al. 2001. Avoidance of allergens and air pollutants in respiratory allergy. *Allergy* 56: 705-722.
- ⁴⁶ Quarles, W. 1999. Dust mites, cockroaches, and asthma. *Common Sense Pest Control* XV (1): 4-18.
- ⁴⁷ Salam, MT, 2004. (Ref. #26)
- ⁴⁸ Wagner, SL. 2000. Fatal asthma in a child after use of an animal shampoo containing pyrethrin. *West J Med* 173: 86-87.
- ⁴⁹ Ibid. Wagner, 2000.

-
- ⁵⁰ Ibid. (Wagner, 2000); Weiner and Worth, 1969. (Ref. #23). National Pesticide Telecommunications Network (NPTN). 1998. Pyrethrins and Pyrethroids. Oregon: Oregon State University. [Hhttp://npic.orst.edu/factsheets/pyrethrins.pdf](http://npic.orst.edu/factsheets/pyrethrins.pdf)H (Accessed August 2005)
- ⁵¹ Ibid (NPTN); Wagner 2000. (Ref. #48).
- ⁵² Cox, C. 2002. Piperonyl butoxide. *Journal of Pesticide Reform* 22 (2): 12-20.
- ⁵³ Kolmodin-Hedman, B, A Swensson, and M Akerblom. 1982. Occupational exposure to some synthetic pyrethroids (permethrin and fenvalerate). *Arch Toxicol* 50: 27-33; Lessenger JE. 1992. Five office workers inadvertently exposed to cypermethrin. *J Toxicol Environ Health* 35: 261-267; Moretto A. 1991. Indoor spraying with the pyrethroid insecticide lambda-cyhalothrin: Effects on spraymen and inhabitants of sprayed houses. *Bull WHO* 69 (5): 591-594; Vandenas, O, JP Delwiche, J Auverdin, et al. 2000. Asthma to tetramethrin. *Allergy* 55: 418-419.
- ⁵⁴ Bayer CropScience. 9/22/2003. Material Safety Data Sheet for TEMPO SC Ultra Insecticide.
- ⁵⁵ Eskenazi, B, A Bradman, and R Castorina. 1999. Exposures of children to organophosphate pesticides and their potential adverse health effects. *Environmental Health Perspectives* 107(Suppl 3): 409-419.
- ⁵⁶ Sanborn, MD, D Cole, A Abelsohn, and E Weir. May 28 2002. Identifying and managing adverse environmental health effects: 4. Pesticides. *CMAJ* 166 (11): 1431-1436; Hurst, P, A Hay, and N Dudley. 1991. *The Pesticide Handbook*. London: Journeyman Press, 84-85.
- ⁵⁷ Eskenazi, 1999. (Ref. #55).
- ⁵⁸ Leikauf, GD. 2002. Hazardous air pollutants and asthma. *Environmental Health Perspectives* 110 (Suppl 4): 505-526.
- ⁵⁹ Eskenazi, 1999. (Ref. #55).
- ⁶⁰ Royce, S. et al, 1993. Draper, A, P Cullinan, C Campbell, et al. 2003. Occupational asthma from fungicides fluzinam and chlorothalonil. *Occup Environ Med* 60: 76-77.
- ⁶¹ Quarles, 1999. (Ref. #46).
- ⁶² Ibid. (Quarles).
- ⁶³ Clark, NM, RW Brown, E Parker, et al. 1999. Childhood asthma. *Environmental Health Perspectives* 107 (Supp 3): 421.
- ⁶⁴ Liccardi, et al. 2001. (Ref. #45).
- ⁶⁵ Eggleston, PA. 2001. Methods and effectiveness of indoor environmental control. *Ann Allergy Asthma Immunol* 87 (6 Suppl 3): 44-47.
- ⁶⁶ Ibid. (Eggleston).
- ⁶⁷ Nicholas, SW, B Jean-Louis, B Ortiz, et al. 2005. Addressing the Childhood Asthma Crisis in Harlem: The Harlem Children's Zone Asthma Initiative. *American Journal of Public Health* 95 (2): 245-249.
- ⁶⁸ Thier A, J Enck, and C Klossner. 1998. *Plagued by Pesticides: An Analysis of New York State's 1997 Pesticide Use and Sales Data*. Albany, NY: Environmental Advocates. [Hhttp://www.eany.org/reports/pesticides/plague.html](http://www.eany.org/reports/pesticides/plague.html)H (Accessed August 2005).
- ⁶⁹ Landrigan, 1999. (Ref. #16).
- ⁷⁰ Ibid. (Landrigan).
- ⁷¹ Perera, FP, SM Illman, PL Kinney, et al. 2002. The challenge of preventing environmentally related disease in young children: Community-based research in New York City. *Environmental Health Perspectives* 110 (2): 197-204.
- ⁷² Solomon, 2004. (Ref. #21).
- ⁷³ Immerman, FW and JL Schaum. 1990. Nonoccupational Pesticide Exposure Study. EPA Doc. No. 600/S3-90/003. *Cited in* Quarles 1999 (Ref. #46).
- ⁷⁴ Sanborn, 2002. (Ref. #56).
- ⁷⁵ Roberts, JW, and P Dickey. 1995. Exposure of children to pollutants in house dust and indoor air. *Rev Environ Contam Toxicol* 143: 59-78.
- ⁷⁶ Gallia, K. 2002. How schools are failing our kids: Childhood cases of obesity and asthma have hit record levels. Meanwhile, public schools serve hamburgers and fries, eliminate gym classes, and use pesticides. Are schools setting our kids up for a lifetime of poor health? *Natural Health* July 2002.
- ⁷⁷ Alarcon, WA, GM Calvert, JM Blondell, et al. 2005. Acute illnesses associated with pesticide exposure at schools. *JAMA* 294 (4): 455-465.
- ⁷⁸ Rajotte, A. 2004. Asthma and pesticides in public schools: Does the ADA provide a remedy where FIFRA fails to protect? *Boston College Environmental Affairs Law Review*. 31: 149-175.
- ⁷⁹ Hood, E. 2005. Investigating indoor air. *Environmental Health Perspectives* 113 (3).
- ⁸⁰ Rajotte, A. 2004. (Ref. #78).