Environmental influences on agricultural worker health

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Pesticides and agricultural worker health

Pesticides are used extensively in farm working communities to control harmful pests and prevent crop yield loss. Each year, an estimated one billion pounds of pesticides are applied to U.S. farms, forests, lawns and golf courses. More than 17,000 pesticide products are currently on the market. Adults and children from farm-working communities have significantly higher risk for exposure to harmful pesticides compared to their non-farming counterparts.1-6 Pesticide compounds enter the body via multiple routes of exposures including ingestion, inhalation, and/or dermal contact. Pesticides are generally classified by their chemical properties (Table 1), with each class affects health through different biologic mechanisms.

Table 1. Commercially available pesticides by chemical class.

<table>
<thead>
<tr>
<th>Pyrethroids</th>
<th>Organophosphates</th>
<th>Organochlorines</th>
<th>Carbamates</th>
<th>Dicarboximides</th>
<th>Organonitrogen</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bifenthrin</td>
<td>Chlorfenvimphos</td>
<td>Chlorothalonil</td>
<td>Carbaryl</td>
<td>Captan</td>
<td>Aldicarb</td>
<td>Bromopropylate</td>
</tr>
<tr>
<td>Cypermethrin</td>
<td>Chlorpyriphos</td>
<td>a-Endosulfan</td>
<td>Fenoxycarb</td>
<td>iprodione</td>
<td>Benomyl</td>
<td>(Benzilate,</td>
</tr>
<tr>
<td>Deltamethrin</td>
<td>Chlorpyriphos-β</td>
<td>β-Endosulfan</td>
<td></td>
<td></td>
<td>Carbendazim</td>
<td>Acaricide</td>
</tr>
<tr>
<td>Permethrin</td>
<td>Methyl</td>
<td>Endosulfan-</td>
<td></td>
<td></td>
<td>Carbofuran</td>
<td>Buprinate</td>
</tr>
<tr>
<td>Resmethrin</td>
<td>Dimethoate</td>
<td>Sulfate</td>
<td></td>
<td></td>
<td>Chlorprophane</td>
<td>(Pyrimidine,</td>
</tr>
<tr>
<td>Sumithrin</td>
<td>Omethoate</td>
<td>Lindane</td>
<td></td>
<td></td>
<td>Diuron</td>
<td>Fungicide</td>
</tr>
<tr>
<td>Phosalone</td>
<td>Tetrachloride</td>
<td></td>
<td></td>
<td></td>
<td>(herbicide)</td>
<td>Metalaxyl</td>
</tr>
<tr>
<td>Primiphos-β</td>
<td>p.p.-DDT</td>
<td></td>
<td></td>
<td></td>
<td>Formetanate</td>
<td>(Acyllalanine,</td>
</tr>
<tr>
<td>Methyl</td>
<td>p.p.-DDE</td>
<td></td>
<td></td>
<td></td>
<td>Methiocarb</td>
<td>Fungicide</td>
</tr>
<tr>
<td>Triazophos</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Methomyl</td>
<td>Thiopanate-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Oxamyl</td>
<td>Methyl</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Propoxur</td>
<td>(fungicide)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Propan</td>
<td>(fungicide)</td>
</tr>
</tbody>
</table>

Due to high biological activity (e.g., endocrine disruption, nerve suppression) and in many cases, long persistence in the environment (i.e., organochlorine), pesticides have been linked to many undesirable human health effects ranging from acute, sub-chronic to chronic effects (Table 2).7-10
Table 2. Selected health outcomes associated with pesticide exposures

<table>
<thead>
<tr>
<th>Unborn babies</th>
<th>Children</th>
<th>Farmers/adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth defects</td>
<td>Brain cancer</td>
<td>Non-Hodgkin’s Lymphoma</td>
</tr>
<tr>
<td>Autism</td>
<td>Leukemia</td>
<td>Parkinson’s Disease</td>
</tr>
<tr>
<td>Delayed development</td>
<td>Asthma</td>
<td>Low sperm count</td>
</tr>
<tr>
<td>ADHD</td>
<td>Poor neurobehavioral development</td>
<td>Cancer</td>
</tr>
<tr>
<td>Restricted growth</td>
<td>Respiratory diseases</td>
<td>Skin, eye, lung irritation</td>
</tr>
<tr>
<td>Preterm birth</td>
<td>Skin, eye, lung irritation</td>
<td>Genotoxicity</td>
</tr>
<tr>
<td></td>
<td>Genotoxicity</td>
<td></td>
</tr>
</tbody>
</table>

In agricultural communities, pesticide exposure is attributed to higher rates of birth adverse birth outcomes (discussed later in ‘Pregnancy outcomes in farm working communities’), developmental delays, respiratory complications, and cancer among children. Among adults, chronic exposures to pesticides have been linked to genotoxicity, declined neuropsychological functioning, various types of cancer, poor mental health, respiratory complications, and cardiovascular diseases. Although many pesticides associated with reproductive effects are no longer widely used in the US, employment in agriculture appears to be associated with activation of physiological, biological, and pathological processes that may lead to infertility. Acute exposure to these chemical compounds can lead to immediate toxicological symptoms, including watery eyes, coughing, running nose, dizziness, muscle ache, nausea, and seizures.

Despite higher exposure to pesticides compared to non-farming communities, there is a significant level of risky behaviors among pregnant agricultural workers related to hand-washing, bathing, protective clothing, house cleaning, and eating produce from the field. Agricultural workers are usually unaware of the pesticides they are exposed to, their health effects, nor the laws that aim to protect them from exposure. They are insufficiently informed to take the necessary precautions to protect them against the risks, and often do not know the nature of their illness and are motivated to keep working to support their families. Even physicians are not well-trained to recognize and manage health outcomes related to pesticide exposures.

Although there has been significant attention to the health effects of pesticides on human health, there has been little focus on the vulnerable agricultural worker population, and significant methodologic barriers make these studies extremely difficult to conduct. The leading obstacles are difficulties in establishing the population at risk and access to health information. Many existing studies on agricultural communities suffer from small sample size. UC Merced is located within an agricultural community and is well positioned to study health effects of pesticide exposures among this vulnerable population, which include a large proportion of migrant workers, whose representation in existing research is significantly limited.
Climate change and health in agricultural communities

Climate change is the biggest public health threat of the 21st century and is predicted to cause dramatic changes in the environment, especially increased episodes of heat, severe weather, dust and allergens.\textsuperscript{37} In addition to agricultural effects,\textsuperscript{38} despite human’s ability to acclimate, climate change has been linked to a myriad of health effects ranging from injury to cardiorespiratory diseases, infectious disease, mental health and even death. Multiple pathways have been suggested to explain the health effects of climate change (Figure 1),\textsuperscript{39-46} and the farm working community is one of the first to be affected given the nature of their work.

Despite concerted attention on the health effects of climate change, very little is being addressed at this time on the effects of climate change on occupational risks of farmers and agricultural workers due to multiple reasons. The informal, seasonal, and subcontracted nature of agricultural labor makes it difficult to count agricultural workers. Undocumented agricultural workers and their employers may be reluctant to share information. In addition, workers with health concerns may not report their experiences due to lack of reporting systems, fear of retaliation, or failure to recognize symptoms. The lack of accurate and complete data makes every aspect of research, education, and advocacy on agricultural worker issues more difficult. More importantly, effective public health interventions to protect the health of this vulnerable population cannot be implemented.
Lastly, because agriculture is both vulnerable to changes in climate and a significant source of greenhouse gases, research supporting coordinated adaptation and mitigation initiatives in this population is critical. However, perceived risk in climate change among farmers is not optimal, and that few endorse greenhouse gas reduction, suggesting that more outreach and community-based efforts to gain their trust are necessary. 47,48

**Pregnancy outcomes among agricultural workers**

As previously discussed, the agricultural industry has some of the highest incidence rates of occupational injuries and illnesses resulting from accidents, falls, excessive heat, repetitive motion and adverse pesticide exposure 49,50. Although the incidence of adverse pregnancy outcomes among female agricultural workers is not clear, women agricultural workers and their fetuses may have increased risk of negative health outcomes due to environmental and occupation risk factors.51

While a few studies failed to demonstrate an association between farm working related exposures and adverse pregnancy outcomes,52,53 many more have shown the contrary. Exposures to agricultural pesticides related with farm working is consistently linked to increased time to pregnancy 51,54-56 (i.e. decreased fecundability), as well as infertility57. For those who can conceive, newborns of farmers have higher risk of preterm delivery, low birthweight, small for gestational age.58 Maternal employment in agriculture is associated with various types of birth defects 59-63 including limb defect,64 orchidopexies,65 spina bifida.66 In ten agricultural counties of California, proximity to commercial pesticide applications was associated with an elevated risk of fetal death due to congenital anomalies with the largest risks for fetal death due to congenital anomalies were from pesticide exposure during the 3rd-8th weeks of gestation. 67,68

Studies have shown that female agricultural workers are generally aware that exposures to pesticides and other occupational hazards affect pregnancy and child health; however, they report not receiving information about these specific risks in mandated pesticide training nor, do health care providers routinely discuss these issues with them during pregnancy.69 They also report lack of control over workplace conditions 70. Interviews with rural health care providers reveal limited knowledge about agricultural work or occupational and environmental health risks during pregnancy.71

Many studies on pregnancy-related outcomes among agricultural workers focus on fetal/reproductive outcomes as described. A pregnant woman goes through multiple complex physiological and psychological changes to accommodate the fetus and is also vulnerable to occupational risks related to farm working.

Gestational complications including gestational hypertension, gestational diabetes, cardiovascular diseases, and asthma are increasingly common disorders of pregnancy in the general populations.72-76 However, to date, no study has examined these outcomes among farm working pregnant women.

More recently, paternal exposures to environmental hazards within farming communities have also been implicated with respect to pregnancy outcomes and merit attention.57,59,66 As the agricultural
communities become more diverse, and known risk factors for pregnancy outcomes (e.g., maternal age, chronic diseases) become more prevalent, it is critical to learn more about pregnancy outcome in this vulnerable population.

**Air quality in agricultural workers communities**

There are few studies that examine the impact of air quality in agricultural worker communities. The only study conducted on the realm of air quality was focused on childhood asthma and ecosyndemics that could be attributed to air pollution exposure. The study used ethnographic and photovoice methods to demonstrate how industrial farming conditions expose children of agricultural workers to environmental pollutants such as bovine contamination, agricultural burning, pesticide exposure, and substandard housing. The student found that children of Mexican-origin agricultural workers in the San Joaquin Valley have higher rates of asthma compared to children of Mexican descent in both United States and Mexico. Left unanswered is the question of whether overall air pollution exposure is higher in farming communities than urban places in California. Also unknown is whether there is more dust exposure in agricultural worker communities, whether the air pollution exposure varies by crop type (for example almond growing vs other crops), and whether industrial farming creates greater pollution exposure to agricultural worker communities.

**Water Quality and agricultural workers**

There is also a lack of research regarding water quality in agricultural worker communities. Only two studies were found: One focused on Total Coliform in agricultural worker camps in North Carolina and a second examining drinking water disparities among long income and minority communities including small communities in agricultural areas. The studies suggest that water supplied to agricultural worker camps often did not comply with current federal standards. Total coliform bacteria were found in 61 camps with Escherichia coli detected in 2. There were reports that documented a lack of piped water systems or serious water quality problems in low income and minority communities. Left unanswered are the current conditions of water quality for agricultural workers in the agricultural regions of California, including the risks from drinking contaminated water and the disparities in drinking water quality across the state.

**References**


38) Pathak TM, ML; Dahlberg, JA; Kearns, F; Bali, KM; Zaccaria, D. Climate Change Trends and Impacts on California Agriculture: A Detailed Review. Agronomy 2018;8(25).


