High Rates of Suicide, Depression Linked to Farmers' Use of Pesticides

There is growing evidence that long-term pesticide use is linked to alterations in farmers' mental health
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On his farm in Iowa, Matt Peters worked from dawn to dusk planting his 1,500 acres of fields with pesticide-treated seeds. "Every spring I worried about him," said his wife, Ginnie. "Every spring I was glad when we were done."

In the spring of 2011, Ginnie Peters' "calm, rational, loving" husband suddenly became depressed and agitated. "He told me 'I feel paralyzed'," she said. "He couldn't sleep or think. Out of nowhere he was depressed."

A clinical psychologist spoke to him on the phone and urged him to get medical help. "He said he had work to do, and I told him if it's too wet in the morning to plant beans come see me," Mike Rossman said. "And the next day I got the call."
Peters took his own life. He was 55 years old.

No one knows what triggered Peters' sudden shift in mood and behavior. But since her husband's death, Ginnie Peters has been on a mission to not only raise suicide awareness in farm families but also draw attention to the growing evidence that pesticides may alter farmers' mental health.

"These chemicals that farmers use, look what they do to an insect. It ruins their nervous system," Peters said. "What is it doing to the farmer?"

Farming is a stressful job – uncontrollable weather, physical demands and economic woes intertwine with a personal responsibility for land that often is passed down through generations. But experts say that some of the chemicals used to control pests may make matters worse by changing farmers' brain chemistry.

Recent research has linked long-term use of pesticides to higher rates of depression and suicide. Evidence also suggests that pesticide poisoning – a heavy dose in a short amount of time – doubles the risk of depression.

"For years there was a high level of denial in the farming community that mental illness exists, period," said Lorann Stallones, an epidemiologist and psychology professor at Colorado State University. "But there's been a shift – partly because there's more people talking about being mentally incapacitated."

Depression is the most common mental disability in the United States. About 7 percent of U.S. adults annually experience at least one two-week or longer stretch of depression, according to the National Institute of Mental Health. There is no national data on whether farmers and their workers are more prone to depression.

The causes are complex. There "are millions, even billions, of chemical reactions that make up the dynamic system that is responsible for your mood, perceptions, and how you experience life," according to a Harvard Medical School report.
Some research suggests that the chemicals that farmers and their workers spread on fields may alter some of these brain chemicals.

Peters and his wife were among 89,000 farmers and other pesticide applicators in Iowa and North Carolina who have participated in the Agricultural Health Study led by the National Institute of Environmental Health Sciences.

Last month, epidemiologist Freya Kamel and her colleagues reported that among 19,000 studied, those who used two classes of pesticides and seven individual pesticides were more likely to have been diagnosed with depression. Those who used organochlorine insecticides were up to 90 percent more likely to have been diagnosed with depression than those who hadn't used them. For fumigants, the increased risk was up to 80 percent.

"Our study supports a positive association between depression and occupational pesticide use among applicators… and suggests several specific pesticides that deserve further investigation in animal studies and other human populations," the authors wrote in the journal Environmental Health Perspectives.

The major strengths of the research are its large number of participants and its detailed pesticide exposure data, said Stallones, who was not involved in the study.

The applicators were asked about depression when enrolled in the study and then again around 2010. Most previous studies only asked once about depression.

Similar results were found when Kamel and colleagues analyzed the same group from 1993 to 1997. Farmers with the highest number of lifetime exposure days to pesticides were 50 percent more likely to later have a depression diagnosis.

The studies don't prove that pesticides cause depression, but animal testing indicates that it's possible, said Cheryl Beseler, an environmental health researcher at Colorado State University. In rat tests pesticides have altered brain cells, neurotransmitters and production of a protective acid.

In France, farmers who used herbicides were nearly twice as likely to have been treated for depression than those who didn't use herbicides, according to a study published last year. The study of 567 farmers found that the risk was even greater when the herbicide applicators had been doing it for more than 19 years.

The studies suggest that chronic exposure to low levels over time may raise the risk of depression.

It's not surprising she (Kamel) found the links between depression and those who had been poisoned," Stallones said. "But the association held true for those that didn't report poisoning."

Colorado farmers who suffered pesticide poisoning – a large dose in a short period of time – had double the risk of depression during the next three years. In addition, pesticide applicators in the North Carolina and Iowa group who suffered pesticide poisoning were 2.5 more likely to later have a depression diagnosis.

Most insecticides work by disrupting insects' nerve cells. At high enough doses, they can alter human nerve cells as well.

"I don't think there's any question that pesticides can affect the functions of the brain," Kamel said, referring to experiments that found pesticides harm rats' brain tissue and receptors. "There could also be indirect effects. Pesticides can promote other health problems, which could be related to depression."

For instance, Dr. Beate Ritz, a neurologist and professor at the University of California, Los Angeles, found that Californians exposed to pesticides are more likely to have Parkinson's disease. One effect of the neurological disease, characterized by a lack of the chemical dopamine, is depression.

Melani Forti, director of health and safety programs for the Association of Farmworkers Opportunity Programs, said one of the biggest challenges in protecting farmworkers is a lack of scientific evidence for health impacts from pesticides.
"A lot of it is anecdotal, we need more research like this from the federal government," she said. Depression "is yet another health effect from pesticides, and farmworkers need to know about this."

Several studies have linked suicide to pesticide use. In Brazil, workers that used more pesticides were more likely to commit suicide, and in China, a World Health Organization survey of 9,800 people in the rural Zhejiang province revealed that those who stored pesticides in their homes had more than double the risk of having suicidal thoughts.

Wendy Ringgenberg, an assistant professor at the University of Iowa, combed through 19 years of national data and reported that farmers and farm workers were 3.6 times more likely to die of suicide than other professions. However, the study did not examine the causes of suicide.

Ringgenberg noted that "farmers feel occupational stress for many reasons, including management of own company, self-reliance, personal illness, diseases in crop or livestock, long work days, few vacation days, caring for family members, relationships with family members and neighbors, work in a changing world, national and world politics, and weather."

Migrant and seasonal farmworkers face stresses related to working conditions, cultural barriers and being away from home and family, Forti said.

The seven individual pesticides that were linked to depression diagnoses in Kamel's study were the fumigants aluminum phosphide and ethylene dibromide; the phenoxy herbicide 2,4,5-trichlorophenoxyacetic acid (2,4,5-T); the organochlorine insecticide dieldrin; and the organophosphate insecticides diazinon, malathion and parathion.

Of those, "only aluminum phosphide, diazinon, and malathion are still registered and in use," Cathy Milbourn, a spokesperson for the Environmental Protection Agency, said in an emailed response. The EPA cancelled the registrations of ethylene dibromide, 2,4,5-T, dieldrin, and parathion, Milbourn said. Aluminum phosphide, diazinon, and malathion are undergoing EPA review.

Three of the largest pesticide manufacturers – Monsanto, Syngenta and Bayer CropScience – said that they do not produce the seven pesticides linked to depression in Kamel's study, but none would comment on the broader issue of mental health and pesticide use.

Many developed countries, including the United States, have phased out organochlorines and organophosphates, but Stallones said regulations do not fully protect workers.

“It’s really important to consider chronic low level exposure and most regulatory agencies base their work on acute high level exposure, which is not analogous to 20 years of occupational use of the pesticide,” Kamel said. “That’s a problem.”

Neonocotinoids– the newer class of pesticides that Matt Peters was handling when he committed suicide – weren’t included in Kamel’s study. However, they are suspected of causing bee die-offs because they harm bees’ brains and nervous systems. The chemicals’ impacts on humans are unknown since no studies have been conducted.

Peters was heavily exposed to other pesticides, too, including organophosphates, his wife said. “Matt did almost all of his own spraying of the crops,” she said.

Ginnie Peters remembers her husband as an even-keeled, kind, loving man who made it a point to treat younger farmers and farm workers with respect.

A fourth-generation farmer, he left behind a son and daughter. His grandfather, also a farmer, suffered from depression as well.

When he died, it “messed with every piece of my being,” she said.

While there is no evidence to blame the pesticides Peters was handling on his Dallas County farm, Stallones said it’s possible he was poisoned because depression symptoms can show up suddenly after a large dose.

Rossman, the clinical psychologist, said it “certainly seemed that there was a chemical contribution to this man being unable to sleep and emotionally paralyzed.”

But when Rossman and Ginnie Peters sent his blood in for chemical analyses, they were unable to get results due to complications at the medical examiner’s office.

An adjunct professor in environmental and occupational health at the University of Iowa, Rossman said many farmers are open to hearing about the possible dangers of pesticides. But economic realities remain.

“Even if they hear my message, they have to make choices: Do I need to use this chemical for the good of my farm, or do the negative factors – what it could be doing to the insects, food supply and possibly people – make it not worth it?” he said.

Ginnie Peters tries to cope by mounting her new mission: bringing suicide out of the darkness and drawing attention to the chemicals that could be playing a role.

“I don’t have ability to do the science,” she said, “but I have my gut, and what happened to Matt, it had to be the chemicals.”

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Farmworkers Health Study (FWHS) - Epidemiology Branch

http://www.niehs.nih.gov/research/atniehs/labs/epi/studies/fwhs/index.cfm

The Farmworkers Health Study examines the relationship of long-term pesticide exposure in farmworkers and deficits in cognitive and psychomotor function. The research group, headed by Freya Kamel, Ph.D., conducted a cross-sectional study comparing pesticide-exposed farmworkers to unexposed controls. Participants in the study came from a farmworker community in central Florida with a stable population. Most farmworkers in this community worked in one of three types of agriculture: growing and harvesting ornamental ferns, working in nurseries or picking citrus fruit.

To gain access to the community, the group collaborated with the Farmworker Association of Florida, a local advocacy group. The defined target population was limited to members of a local credit union and their spouses, with both exposed farmworkers

and unexposed controls being recruited from this population. The researchers screened 80% of selected individuals and 81% of those eligible participated in the study. The experimental group contained 288 individuals who had worked in the farming industry for at least one month and 51 controls who did not meet this criterion. The study was unique in recruiting a large sample from a defined population with a high response rate.

Since pesticides potentially affect many aspects of neurologic function, the group used a battery of tests—with several being implemented on a computer—to evaluate sensory, motor and cognitive function. The tests were relatively independent of education and cultural background. The researchers collected information on history of farm work, other employment, demographics, lifestyle and medical history using a structured interview administered by trained personnel. They also collected and archived buccal cells to use as a source of DNA. Genetic analyses will focus on genes involved in pesticide metabolism, such as paraoxonase.

In analyses of the relationship of work history to neurobehavioral performance, the team found that having done at least some farm work was associated with poor performance on four tests—digit span, finger tapping, Santa Ana and postural sway—but had little effect on four others: symbol digit latency, vibrotactile threshold, visual contrast sensitivity and grip strength. The affected tests evaluated cognitive and psychomotor function. Associations with farm work were similar in magnitude to associations with personal characteristics such as age and gender. Longer duration of farm work was associated with worse performance. Associations with fern work were more consistent than associations with nursery or citrus work. Deficits related to the duration of work experience were seen in former as well as current farmworkers, and decreased performance was related to chronic exposure even in the absence of a history of pesticide poisoning.

During the last 60 years, pesticide use in the United States has steadily increased. Certain occupational groups as well as the general public may be exposed. Clinical manifestations of neurotoxicity following high level pesticide exposure are well known, but there is growing concern that pesticides may also produce subclinical neurologic deficits, particularly as a delayed consequence of a poisoning episode or in situations of chronic, low-level exposure, and this issue has not been extensively studied. Data from the Farmworkers Health Study led researchers to conclude that long-term experience of farm work is associated with measurable deficits in cognitive and psychomotor function. The study extended previous findings by demonstrating farm work-related neurologic deficits in a large, population-based study that compared workers in different types of agriculture.

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Perspectives - Correspondence

Pesticides and Neurologic Symptoms: Kamel et al. Respond

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See the letter "Pesticides and Neurologic Symptoms" on page A800a.

Burns and Goldstein raise several issues regarding our paper (Kamel et al. 2005), in which we reported that applicators chronically exposed to moderate levels of pesticide experience more neurologic symptoms. They assert that our measures of exposure and effect are not “meaningful.” We disagree.

Burns and Goldstein state that “‘multiple symptoms’ is not a definable disease or illness.” Although this is true, symptoms cause many medical visits and so are significant to public health. Further, we made no claim that applicators reporting more symptoms had a particular disease. Indeed, in some of our analyses we purposely excluded individuals reporting neurologic disease in order to evaluate associations of pesticide use specifically with symptoms. We studied a mixed group of symptoms, all sometimes associated with neurologic dysfunction or disease, although with varying specificity.

Excluding two relatively nonspecific symptoms (headache and fatigue) did not appreciably change the distribution of the symptom variable. The assertion that we limited our analysis to ”a single episode” is inaccurate: our main analyses evaluated multiple rather than single symptoms, and we took symptom frequency into account in our analysis of individual symptoms (Kamel et al. 2005; Table 4). We acknowledged the limitations of cross-sectional analysis in our article. However, the associations we observed were with cumulative pesticide use; accounting for recent use did not change results.

The issue is not whether the symptoms we studied are diagnostic of neurologic or other disease, but whether experiencing these symptoms is associated with pesticide exposure. Burns and Goldstein cite Lundberg et al. (1997) but omit Lundberg et al.'s conclusion that the exposure-related relationship of symptom reporting to organic solvent exposure makes this approach useful for comparing groups with different exposures. At least 23 previous studies used symptom reporting to evaluate neurologic effects of pesticide exposure, with 19 reporting positive associations (Kamel and Hoppin 2004). We extended this approach to a very large group of applicators who had detailed exposure information available.

Burns and Goldstein discuss potential factors related to symptoms, citing Spurgeon's biopsychosocial model (Spurgeon et al. 1996). We agree that personal and social factors likely influence both experience and reporting of symptoms.

However, Spurgeon (2002) noted that: *Discussion of the determinants of symptom reporting does not constitute a dismissal of the farmer's illness but simply a recognition that it is likely to result from a complex interaction of physical, psychological, and social processes.*

She described a study of farmers whose symptoms were associated with five factors, one being handling sheep within 48 hr of pesticide dipping. Thus, pesticide exposure may still be associated with increased symptoms even (or perhaps especially) when psychosocial factors are taken into account. Most of the factors Burns and Goldstein list are unlikely to be related to exposure in licensed applicators and so cannot explain the associations seen. Further, confounding by psychosocial factors would likely produce associations with all types of pesticides, but our findings were specific to insecticides. Finally, we do not understand Burn's and Goldstein's comment that our findings are "the result … of a common ailment such as influenza"; are they suggesting that pesticide exposure is associated with increased risk of flu?

Burns and Goldstein call our exposure measures limited, citing biomonitoring studies which show that variations in internal exposure are not completely correlated with external exposure. This point is largely irrelevant because the associations seen depend not on identifying the absolute level of pesticide exposure but rather on ranking applicators as relatively more or less exposed. Variation in the degree to which self-reported days of use represents internal exposure is probably nondifferential with respect to symptom reporting, with resulting misclassification likely to bias associations towards the null; the true relationship may be stronger than we observed. Our findings of associations with insecticides only, and with cumulative but not recent exposure, suggest that recall bias does not fully account for our results. We see no problem in combining pesticides for a class-wide analysis, particularly because many grouped pesticides exert effects through similar or related biologic mechanisms. Using class-wide analyses may minimize confounding because most applicators used multiple pesticides. Ultimately, it will be interesting to evaluate the effects of individual chemicals; we are planning such studies.

Thus, our measures of both exposure and effect are sufficient for their purpose, which is to examine the association of symptom reporting with moderate insecticide exposure. Our study clearly demonstrates such an association. Importantly, it is independent of both recent exposure and a history of high exposure or poisoning, suggesting that lifetime exposure at moderate levels may have health consequences. This finding has implications for farmers' health and deserves to be reported and evaluated further.

References

- Kamel F, Engel LS, Gladen BC, Hoppin JA, Alavanja MCR, Sandler DP. Neurologic symptoms in licensed private pesticide applicators in the Agricultural Health Study. Environ Health Perspect. 2005; 113: 877–882. [PMC free article] [PubMed]
- Kamel F, Hoppin JA. Association of pesticide exposure with neurologic dysfunction and disease. Environ Health Perspect. 2004; 112: 950–958. [PMC free article] [PubMed]
- Lundberg I, Hogberg M, Michelsen H, Nise G, Hogstedt C. Evaluation of the Q16 questionnaire on neurotoxic symptoms and a review of its use. Occup Environ Medicine. 1997; 54: 343–350. [PMC free article] [PubMed]
- Spurgeon A. Models of unexplained symptoms associated with occupational and environmental exposures. Environ Health Perspect. 2002; 110 (suppl 4): 601–605. [PMC free article] [PubMed]
- Spurgeon A, Gompertz D, Harrington JM. Modifiers of non-specific symptoms in occupational and environmental syndromes. Occup Environ Med. 1996; 53: 361–366. [PMC free article] [PubMed]