

## Agricultural Health Study

### Key Points

- The Agricultural Health Study (AHS) is designed to investigate relationships between aspects of living and working on a farm—including hazardous substance exposures—and cancer risk, as well as relationships with other health problems (see Question 1).
- The AHS cohort includes nearly 90,000 men and women who live in Iowa or North Carolina (see Question 2).
- Most of the cancer research in the AHS has focused on pesticides (see Question 5).
- Thus far, researchers have investigated more than 20 pesticides. Some of these analyses have suggested that people exposed to certain pesticides may have an increased risk of developing one or more types of cancer (see Question 5).

### 1. What is the Agricultural Health Study?

In 1993, scientists from the National Cancer Institute, the National Institute of Environmental Health Sciences, and the Environmental Protection Agency (EPA) began a research project known as the Agricultural Health Study (AHS) to evaluate the role of agricultural exposures in the development of cancer and other diseases in members of the farming community. The National Institute for Occupational Safety and Health joined the study in 2000.

The AHS is also providing an opportunity to assess the effects of diet, cooking methods, and other lifestyle and genetic factors on the risks of cancer and other diseases. The results will provide information that can be used to create a safe work environment and a healthy lifestyle for agricultural workers and their families.

More information about the study can be found online at <http://www.aghealth.nci.nih.gov/>.

### 2. Who are the participants?

The vast majority of the nearly 90,000 participants in the AHS are either farmers or the wives of farmers; about 52,000 are farmers and 32,000 are wives of farmers. All of the participants were recruited in North Carolina or Iowa.

Participants classified as "private pesticide applicators" are farmers or nursery workers. The study also includes a small percentage of "commercial pesticide applicators" from Iowa who work for pest control companies or for businesses, such as warehouses or grain mills, that use pesticides regularly; about 5,000 participants are commercial applicators.

### 3. What are some of the cancer trends among farmers?

Farmers in many countries, including the United States, have lower overall death rates and cancer rates than the general population. Lower death rates among farmers for heart disease and cancers of the lung, esophagus, bladder, and colon, in particular, are thought to be due, at least in part, to lower smoking rates, as well as more physically active lifestyles and dietary factors.

However, compared with the general population, the rates for certain diseases, including some types of cancer, appear to be higher among agricultural workers, which may be related to exposures that



are common in their work environments. For example, farming communities have higher rates of leukemia, non-Hodgkin lymphoma, multiple myeloma, and soft tissue sarcoma, as well as cancers of the skin, lip, stomach, brain, and prostate.

Even though no one set of risk factors explains these higher cancer rates, the range of environmental exposures in the farming community is of concern. Farmers, farm workers, and farm family members may be exposed to substances such as pesticides, engine exhausts, solvents, dusts, animal viruses, fertilizers, fuels, and specific microbes that may account for these elevated cancer rates. However, human studies reported to date have not allowed researchers to sort out which of these factors may be linked to which cancer types.

#### **4. What types of information do AHS participants provide during the study?**

From 1993 through 1997, when participants were being recruited for the study, they completed a questionnaire about their crops and livestock, the pesticides and personal protective equipment they used, how they applied pesticides, and other things they may have been exposed to on the farm, such as solvents, grain dusts, and welding fumes. They were also asked about nonfarm activities and exposures that may affect disease risks, such as diet, exercise, alcohol consumption, medical conditions, family history of cancer, other occupations, and smoking history.

Since then, researchers have been using the following methods to collect additional information:

- Computer-assisted telephone interviews to gather information about pesticide use since study enrollment, changes in health status, and detailed information about farming and work practices.
- Mailed dietary health questionnaires to gather detailed information about cooking practices and diet.
- Collection of buccal (cheek) cells to determine whether specific alterations found in DNA are related to disease susceptibilities associated with agricultural exposures.
- Records from cancer registries in each state to determine which participants developed cancer.
- Records from the U.S. National Death Index, a computerized index of death records collected from all state vital statistics offices and available to scientists for medical and health research.

In addition, a series of smaller analyses are focusing on risk factors for specific diseases. These analyses may involve additional questionnaires and the collection of blood, tumor, urine, or dust samples.

#### **5. What have researchers learned so far about farmers and cancer risk?**

Most of the cancer research in the AHS has focused on pesticides, which are chemicals used to kill invasive insects, weeds, or small animals. In some cases, relationships between these pesticides and human cancer were examined for the first time in the AHS.

Thus far, researchers have evaluated more than 20 pesticides to determine whether the farmers who use them have increased risks of developing cancer. Some of these analyses have shown that people exposed to certain pesticides have an increased risk of developing certain cancers, but further research is needed to confirm these findings and to evaluate the potential mechanisms by which pesticides might influence cancer risk.

For example, a study from the AHS reported in 2009 that people who use the weed killer imazethapyr have increased risks of bladder cancer and colon cancer. Imazethapyr is in a class of chemicals known as aromatic amines. It was first used in the United States in 1989, and, since then, has been one of the most commonly used herbicides for killing weeds in soybean, dry bean, alfalfa, and other crop fields.

Studies in mice and rats led the EPA to classify imazethapyr as unlikely to be a human carcinogen. But, in the AHS, people with the highest cumulative lifetime exposure had more than twice the risk (137 percent increase in risk) of developing bladder cancer compared with those who had no exposure to the chemical. Similarly, the risk of colon cancer (mostly tumors in the proximal colon, where food enters during digestion) was nearly twice as high as normal (78 percent increased risk) among farmers who had the highest level of exposure compared with those who had no exposure to the chemical.

In addition, a condition called monoclonal gammopathy of undetermined significance (MGUS), which commonly precedes multiple myeloma, was found in blood samples of men in the AHS at twice the rate it was found in blood samples of men in Minnesota who were not part of the AHS cohort. This increased risk of MGUS was observed among men who used the chlorinated insecticide dieldrin, the fumigant mixture carbon-tetrachloride/carbon disulfide, the fungicide chlorothalonil, and possibly other pesticides. Now, a larger study within the AHS is looking more closely at the risk of MGUS with use of specific pesticides.

In 2011, AHS researchers reported an analysis of farmers who use the weed killer atrazine, which is a type of chemical known as a triazine. In this analysis, farmers who used atrazine the most often had a similar overall cancer risk to those who used atrazine the least often, but those with the highest exposures had a slightly increased risk of thyroid cancer. However, the number of cancer cases was too few for the finding to be considered conclusive.

Atrazine causes mammary tumors in rats but is not classified as a carcinogen in humans. Atrazine is an endocrine disruptor—meaning that it interferes with normal hormone signals in the body—as demonstrated in amphibians, birds, and rodents that have been exposed to it at high concentrations.

More information about what researchers have learned about cancer, other health problems, and risk factors among farmers is available in the AHS publications list at <http://www.aghealth.nci.nih.gov/publications.html>.

### Selected References

1. Koutros S, Alavanja MC, Lubin JH, et al. An update of cancer incidence in the Agricultural Health Study. *Journal of Occupational and Environmental Medicine* 2010; 52(11):1098–1105. [[PubMed Abstract](#)]
2. Koutros S, Lynch CF, Ma X, et al. Heterocyclic aromatic amine pesticide use and human cancer risk: results from the U.S. Agricultural Health Study. *International Journal of Cancer* 2009; 24(5):1206–1212. [[PubMed Abstract](#)]
3. Landgren O, Kyle RA, Hoppin JA, et al. Pesticide exposure and risk of monoclonal gammopathy of undetermined significance in the Agricultural Health Study. *Blood* 2009; 113(25):6386–6391. [[PubMed Abstract](#)]
4. Beane Freeman LE, Rusiecki JA, Hoppin JA, et al. Atrazine and cancer incidence among pesticide applicators in the Agricultural Health Study (1994–2007). *Environmental Health Perspectives* 2011; online May 27, doi:10.1289/ehp.1103561. [[PubMed Abstract](#)]

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### Related NCI materials and Web pages:

- Agricultural Health Study Home Page (<http://www.aghealth.nci.nih.gov>)
- Cancer Causes and Risk Factors Home Page (<http://www.cancer.gov/cancertopics/causes>)
- Understanding Cancer Series: Cancer and the Environment (<http://www.cancer.gov/cancertopics/understandingcancer/environment>)

### How can we help?

We offer comprehensive research-based information for patients and their families, health professionals, cancer researchers, advocates, and the public.

- **Call** NCI's Cancer Information Service at 1–800–4–CANCER (1–800–422–6237)
- **Visit** us at <http://www.cancer.gov> or <http://www.cancer.gov/espanol>
- **Chat** using LiveHelp, NCI's instant messaging service, at <http://www.cancer.gov/livehelp>

- **E-mail** us at [cancergovstaff@mail.nih.gov](mailto:cancergovstaff@mail.nih.gov)
- **Order** publications at <http://www.cancer.gov/publications> or by calling 1-800-4-CANCER
- **Get help** with quitting smoking at 1-877-44U-QUIT (1-877-448-7848)

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