

In E

# National Cancer Institute

at the National Institutes of Health

Questions At  
1-800-4-

[NCI Home](#)
[Cancer Topics](#)
[Clinical Trials](#)
[Cancer Statistics](#)
[Research & Funding](#)
[News](#)

## NATIONAL CANCER INSTITUTE FactSheet



Rev

### Search Fact Sheets by Keyword



### Page Options

[Print This Page](#)  
[Email This Document](#)  
[View/Print PDF](#)  
[Bookmark & Share](#)

[RSS Feed](#)

### View Fact Sheets by Topic

[Cancer Type](#)  
[Risk Factors and Possible Causes](#)  
[Prevention](#)  
[Detection/Diagnosis](#)  
[Cancer Therapy](#)  
[Support/Coping/Resources](#)  
[Tobacco/Smoking Cessation](#)  
[Information Sources](#)  
[About NCI](#)  
[Cancer Health Disparities](#)  
[Cancer Advances In Focus](#)  
[Index](#)  
[En español](#)

### Quick Links

[Director's Page](#)  
[Dictionary of Cancer Terms](#)  
[NCI Drug Dictionary](#)  
[Funding Opportunities](#)  
[NCI Publications](#)  
[Advisory Boards and Groups](#)  
[Science Serving People](#)  
[Español](#)

## No Excess Mortality Risk Found in Counties with Nuclear

A [National Cancer Institute](#) (NCI) survey published in the *Journal of the American Medical Association* March 20, 1991, showed no general increased risk of death from [cancer](#) for people living in counties containing or closely adjacent to 62 nuclear facilities. The facilities in the survey were in operation before 1982. Included were 52 commercial nuclear power plants, nine Department of Energy research and weapons plants, and one commercial fuel reprocessing plant. The survey included data from 16 types of cancer, including [leukemia](#). In the counties with nuclear facilities, cancer rates before and after the startup of the facilities were compared with cancer rates in 292 similar nuclear facilities (control counties).

The NCI survey showed that, in comparison with the control counties, some of the study counties had higher rates of certain cancers and some had lower rates, either before or after the facilities began operation. None of the differences that were observed could be linked with the presence of nuclear facilities. "From the data at hand, there was no convincing evidence of any increased risk of death from cancer we surveyed due to living near nuclear facilities," said John Boice, Sc.D., who heads the [Radiation Epidemiology Branch](#) at the time of the survey.

Dr. Boice cautioned, however, that the counties may be too large to detect risks present only in areas around the plants. "No study can prove the absence of an effect," said Dr. Boice, "but if a risk due to radiation pollution is present in counties with nuclear facilities, the risk is too small to be detected by the methods used."

The survey, conducted by Seymour Jabon, Zdenek Hrubec, Sc.D., B.J. Stone, Ph.D., began in 1987 for scientific purposes in response to American public health concerns about cancer mortality in areas around nuclear installations in the United Kingdom and a British study of childhood leukemia deaths near some facilities.<sup>1</sup> No increases in total cancer mortality were found in the British study, and other smaller surveys of cancer deaths around nuclear facilities in the United Kingdom have yielded conflicting results.

The NCI [scientists](#) studied more than 900,000 cancer deaths in the study counties using records collected from 1950 to 1984. The researchers evaluated changes in mortality rates for cancer in these counties from 1950 until each facility began operation and from the start of 1984. For four facilities in two states (Iowa and Connecticut), cancer [incidence](#) data were available. Data on cancer incidence in these counties resembled the county's mortality data pattern.

For each of the 107 study counties, three control counties that had populations similar in income and other socioeconomic factors, but did not have or were not near nuclear facilities, were used for comparison. The study and control counties were within the same geographic region and the same state. Over 1.8 million cancer deaths were studied in the control counties.

The numbers of cancer deaths in the study counties and in the control counties were analyzed to determine the relative risk (RR) of dying of cancer for persons living near a nuclear facility. A relative risk of 1.00 means that the risk of dying of cancer was the same in the study county and in the control county; any number below 1.00 indicates that the overall risk was lower in the study county than in the control county; and any number greater than 1.00 indicates a higher risk in the study county. For example, a relative risk of 1.04 would indicate that there was a 4 percent higher risk of cancer death in the study county. Conversely, an RR of 0.93 would indicate a 7 percent lower risk in the study county.

For childhood leukemia in children from birth through age 9 years, the overall RR compared to control counties before the startup of the nuclear facilities was 1.08; after startup the RR

data indicate that the risk of childhood leukemia in the study counties was slightly greater than the nuclear facilities than after. The risk of dying of childhood cancers other than leukemia slightly from an RR of 0.94 before the plants began operation to an RR of 0.99 after the plants were operating.

For leukemia at all ages, the RRs were 1.02 before startup and 0.98 after startup. For other childhood cancers, the RRs were essentially the same: 1.00 before startup and 1.01 after startup. There is no evidence that the presence of nuclear facilities influenced cancer death rates in the study counties.

### **Questions and Answers National Cancer Institute (NCI) Survey Cancer Mortality in Populations Living Near Nuclear Facilities**

#### **1. Which nuclear facilities were included in the survey?**

Only major nuclear facilities that are or once were in operation and went into service were included in the survey. All 52 commercial nuclear power facilities in the United States that started before 1982 were included. A facility may include more than one reactor.

In addition to the commercial nuclear power facilities, nine U.S. Department of Energy nuclear installations and one commercial fuel reprocessing plant were included. These facilities do not generate electrical power for commercial use.

Facilities such as small research reactors at universities were not included. See the Appendix for a complete list of facilities.

#### **2. Why were the DOE facilities included?**

In the British study that helped to prompt this survey, an excess of childhood leukemia was found mainly around nuclear installations that were involved in the enrichment, fabrication, and reprocessing of nuclear fuel or research and development of nuclear weapons. The facilities included in the study are similar to these British facilities.

Also, some DOE installations have been operating since 1943, which is longer than the first commercial nuclear power plant in the United States. The first commercial nuclear power plant was built in 1957.

The DOE facilities were evaluated both as part of the total group of nuclear facilities and as a separate group.

#### **3. Which counties were included in the survey?**

All counties with a major nuclear facility that is or once was in operation and went into service before 1982 were included in the survey as study counties. Other adjacent counties that are one-fifth of the land that lies within a 10-mile radius of these facilities were also included. In total, 107 counties were identified as study counties. See the [Appendix](#) for a complete list.

For each study county, three control counties within the same geographic region that are not near nuclear facilities were identified for comparison. Control counties were the most similar to study counties based on population size and socioeconomic characteristics such as race and income.

#### **4. What were the 16 types of cancer surveyed?**

The following 16 types of cancer were surveyed: leukemia; all cancers other than leukemia (group); Hodgkin lymphoma; lymphomas other than Hodgkin lymphoma; multiple myeloma of the digestive organs (as a group and separately), including cancer of the stomach, rectum, and liver; cancer of the trachea, bronchus, and lung; female breast cancer; cancer of the bone and joints; bladder cancer; brain and other central nervous system tumors; other benign or unspecified tumors.

#### **5. Why was childhood leukemia a special focus of the analysis?**

The excess risk identified in the British study pertained to leukemia deaths among children under the age of 25. Leukemia is one of the major cancers induced by high doses of radiation. It can occur as soon as 2 years after exposure. Other cancers associated with high-dose radiation do not develop until 10 years after exposure.

Studies have also suggested that children are more sensitive to the cancer-producing radiation than adults. Children may spend more time in and around the home than jobs may take them to other areas. They are also more likely to come in close contact upon which radioactive releases may have been deposited following discharges.

**6. Why were cancer deaths (mortality) compared instead of the number of cancer cases (incidence)?**

Although data on cancer incidence (the number of newly diagnosed cases in a given year) could provide a more complete evaluation of the possible impact of living near nuclear facilities, cancer incidence data for the entire Nation do not exist. The reporting of county-level cancer incidence data provides nationwide data that can show important geographic and time-related trends in cancer. In past NCI studies, mortality data have proven useful in developing clues about the causes of cancer and in targeting areas for future research.

Cancer incidence data were available in two states (Iowa and Connecticut) for facilities with cancer registries that provided this information were among those that participate in the National Cancer Surveillance, Epidemiology, and End Results Program and are of high quality. State cancer incidence data resembled results using cancer mortality data.

**7. Did any individual county or plant have an excess risk of cancer death?**

Overall, the risks for childhood leukemia, adult leukemia, and all cancers were about the same in the counties with nuclear installations as in the control counties. The areas around nuclear facilities appeared to have higher risks of leukemia while others had lower risks. Generally, differences are not large and are consistent with the random variations seen when comparing counties based on geographic data.

The county surrounding the Millstone Power Plant located in New London, Connecticut, showed a significant excess of cases of leukemia in children under 10 years of age (shown in Table 1) in comparison to its control counties. The RR was 3.04 after startup of the plant. Before review, the excess risk shown using incidence data arose partly from comparison of low cancer rates in the control counties rather than from a high rate in the study county.

No other excesses of childhood leukemia were found that could be linked to any nuclear facilities. Further, three facilities—San Onofre in Orange County and San Diego (California); Quad Cities in Rock Island County and Whiteside County, Illinois; and Vermont Yankee in Vermont—were marked by significant deficits in the RR for leukemia deaths in children under 10 years of age. The RRs were 0.75, 0.24, and 0.09, respectively.

**8. Is it possible that "chance" could explain some of the high or low relative risks found in the survey?**

Due to the large scope of the study and the many comparisons made, it could be expected that a number of "statistically significant" increased or decreased RRs would be observed. Further, significant variations in rates might also result from underlying differences in cancer risk factors that have nothing to do with the presence of nuclear facilities. Other important risk factors, such as cigarette smoking and diet, might be the cause of observed differences in cancer rates between study and control counties. As expected, comparisons of cancer rates in study and control counties showed substantial variation before operation began. There was no general tendency for cancer rates to be higher after nuclear facilities began operation.

**9. Did the counties with DOE facilities, individually or as a group, have an increased risk of cancer for the surrounding counties?**

The findings for the DOE facilities were similar to those for the electricity-generating facilities. There was no overall suggestion of cancer excesses that could be attributed to the presence of nuclear facilities. The lone commercial fuel reprocessing plant was included in the group of DOE facilities.

For these counties, the RRs for childhood leukemia (ages birth to 9 years) were about the same before and after facilities began operation and 1.06 after opening. For all other childhood cancers, the RRs were 1.06 and 0.95 before and after operation began, respectively. For leukemia at all ages, the RRs were 1.07 before startup and 0.96 after startup. For other cancer at all ages, the RRs were essentially the same, 1.06 before startup and 1.04 after startup.

**10. Why was the study based on the county as the geographic unit?**

The data for a study based on counties were readily available for the entire United States. The U.S. Environmental Protection Agency has prepared detailed data on cancer by county since 1950. Population data, which are needed to calculate cancer rates, are available by county. Thus, the county was the smallest geographic unit for which nationwide data could be quickly evaluated.

**11. Have similar county-based studies been valuable in the past?**

Yes, surveys using methods that analyze county mortality patterns have been used several times by NCI. Based on findings from NCI "cancer maps" constructed from county mortality statistics, a clustering of lung cancer deaths was seen among residents of counties along the southern Atlantic coast. Across the United States, counties with shipyard industries have elevated rates of lung cancer deaths, particularly in men. Subsequent independent studies of high-risk areas linked the excess lung cancer deaths to asbestos and cigarette smoking in shipyards, especially during World War II.

In another study, mortality rates from lung cancer were found to be elevated among women living in counties with smelters and refineries that emitted arsenic. A previous study had shown arsenic to cause lung cancer in smelter workers who were heavily exposed. Further analytical study of counties with smelters showed an elevated risk of lung cancer with residential exposure to arsenic released by smelters into the local environment.

The county mortality surveys are often considered a first step toward directing future research efforts. These surveys also have their limitations. The county may be too large to represent present conditions in limited areas, death certificates are sometimes not accurate regarding cause of death, and exposures to individuals are unknown.

**12. Would a study based on smaller geographic units be feasible?**

Mortality and population data are not available on a national basis for areas smaller than counties. The data required for studies of small areas, such as cities or neighborhoods, are available at the state or local level when they are available.

Using the existing county mortality data, the survey took 3 years to complete. A survey using data for areas smaller than counties would take much longer.

**13. Were the study design and results reviewed?**

In addition to internal review, the design of the study was evaluated by an expert from outside the U.S. Government who also reviewed the entire intramural research program in the Radiation Epidemiology Branch in the Division of Cancer Etiology (DCE), NCI.

Because of the importance of clarifying any potential health hazards associated with nuclear facilities, a special advisory group was also established to help evaluate the study. The advisory group consisted of selected members of DCE's Board of Scientific Consultants, as well as other scientists from outside the U.S. Government with expertise in radiation effects.

**14. What levels of radiation might be expected from the normal operation of nuclear facilities studied?**

Reported radioactive releases from monitored emissions of nuclear facilities in the United States show very low radiation exposure to the surrounding populations. Maximum individual doses from these plants are reported to be less than 5 millirem annually, or less than what is received annually from natural background sources of radiation, such as radon. Levels this low are believed to be too small to result in detectable harm. There have been high releases of radioactive emissions from some facilities, such as the Hanford (Benton, Franklin, and Grant Counties, Washington).

It is important to distinguish between a major release of radioactivity from a reactor, such as the accident at Chernobyl in the former Soviet Union, and the small amounts of radioactivity likely to be emitted by nuclear facilities under normal operation.

**15. Will there be more research on the possible hazards of living near nuclear facilities?**

The NCI county mortality survey is only the initial step in evaluating the possible hazards of living near nuclear facilities. The study provides background information that will complement future research.

other studies being conducted or planned by the Centers for Disease Control and various state health departments, and other groups. Information gained from this ongoing projects will guide future research efforts.

In its consensus statement, the ad hoc advisory committee that reviewed and evaluated has also recommended areas for further research.

The complete three-volume report titled *Cancer in Populations Living Near Nuclear Facilities* ordered from the Superintendent of Documents, U.S. Government Printing Office, Washington 20540-9325. The GPO stock number is 017-042-00276-1.

**Appendix  
Facilities and Counties Included in the Study**

State	County	Study Facility	
<b>Alabama</b>	Houston	Farley	1
	Lawrence	Browns Ferry	1
	Limestone	Browns Ferry	1
<b>Arkansas</b>	Pope	Arkansas	1
<b>California</b>	Amador	Rancho Seco	1
	Humboldt	Humboldt Bay	1
	Orange	San Onofre	1
	Sacramento	Rancho Seco	1
	San Diego	San Onofre	1
	San Joaquin	Rancho Seco	1
<b>Colorado</b>	Boulder	Fort St. Vrain	1
		*Rocky Flats	1
	Jefferson	*Rocky Flats	1
	Larimer	Fort St. Vrain	1
	Weld	Fort St. Vrain	1
<b>Connecticut</b>	Middlesex	Haddam Neck	1
	New London	Millstone	1
<b>Delaware</b>	New Castle	Salem	1
<b>Florida</b>	Citrus	Crystal River	1
	Dade	Turkey Point	1
	St. Lucie	St. Lucie	1
<b>Georgia</b>	Appling	Hatch	1
	Burke	*Savannah River	1
	Early	Farley	1
	Toombs	Hatch	1
<b>Idaho</b>	Bingham	*Idaho National Engineering Lab.	1
	Butte	*Idaho National Engineering Lab.	1
	Jefferson	*Idaho National Engineering Lab.	1
<b>Illinois</b>	Grundy	Dresden	1
	Lake	Zion	1
	Rock Island	Quad Cities	1
	Whiteside	Quad Cities	1
	Will	Dresden	1
<b>Iowa</b>	Benton	Duane Arnold	1
	Harrison	Fort Calhoun	1
	Linn	Duane Arnold	1
<b>Kentucky</b>	Ballard	*Paducah Gas. Diff.	1
	McCracken	*Paducah Gas. Diff.	1
<b>Maine</b>	Lincoln	Maine Yankee	1
	Sagadahoc	Maine Yankee	1

<b>Maryland</b>	Calvert	Calvert Cliffs	1
<b>Massachusetts</b>	Berkshire	Yankee Rowe	1
	Franklin	Vermont Yankee	1
	Plymouth	Yankee Rowe Pilgrim	1 1
<b>Michigan</b>	Berrien	Cook	1
	Charlevoix	Big Rock Point	1
	Emmet	Big Rock Point	1
	Monroe	Fermi	1
	Vanburen	Palisades	1
<b>Minnesota</b>	Goodhue	Prairie Island	1
	Sherburne	Monticello	1
	Wright	Monticello	1
<b>Missouri</b>	Atchinson	Cooper Station	1
<b>Nebraska</b>	Gage	Hallam	1
	Lancaster	Hallam	1
	Nemaha	Cooper Station	1
	Richardson	Cooper Station	1
	Washington	Fort Calhoun	1
<b>New Hampshire</b>	Cheshire	Vermont Yankee	1
<b>New Jersey</b>	Ocean	Oyster Creek	1
	Salem	Salem	1
<b>New York</b>	Cattaraugus	**Nuclear Fuel Services	1
	Oswego	Nine Mile Point/Fitzpatrick	1
	Rockland	Indian Point	1
	Wayne	GINNA	1
	Westchester	Indian Point	1
<b>North Carolina</b>	Brunswick	Brunswick	1
	Gaston	McGuire	1
	Lincoln	McGuire	1
	Mecklenburg	McGuire	1
<b>Ohio</b>	Butler	*Fernald	1
		*Mound	1
	Hamilton	*Fernald	1
	Montgomery	*Mound	1
	Ottawa	Davis Besse	1
	Pike	*Portsmouth Gaseous Diffusion	1
	Warren	*Mound	1
<b>Oregon</b>	Columbia	Trojan	1
<b>Pennsylvania</b>	Beaver	Shippingport/Beaver Valley	1
	Dauphin	Three Mile Island	1
	Lancaster	Peach Bottom	1
		Three Mile Island	1
	York	Peach Bottom	1
		Three Mile Island	1
<b>South Carolina</b>	Aiken	*Savannah River	1
	Barnwell	*Savannah River	1
	Chesterfield	Robinson	1
	Darlington	Robinson	1
	Oconee	Oconee	1
	Pickens	Oconee	1
<b>South Dakota</b>	Lincoln	Pathfinder	1
	Minnehaha	Pathfinder	1
<b>Tennessee</b>	Anderson	*Oak Ridge	1
	Hamilton	Sequoyah	1
	Roane	*Oak Ridge	1

<b>Virginia</b>	Caroline	North Anna	1
	Hanover	North Anna	1
	Isle of Wright	Surry	1
	Louisa	North Anna	1
	Surry	Surry	1
<b>Vermont</b>	Windham	Vermont Yankee	1
<b>Washington</b>	Benton	*Hanford	1
	Cowlitz	Trojan	1
	Franklin	*Hanford	1
	Grant	*Hanford	1
<b>Wisconsin</b>	Kenosha	Zion	1
	Kewaunee	Kewaunee	1
	Manitowoc	Point Beach	1
		Kewaunee	1
	Pierce	Point Beach	1
		Prairie Island	1
Vernon	La Crosse (Genoa)	1	
<b>West Virginia</b>	Hancock	Shippingport/Beaver Valley	1

\*Department of Energy Facility  
 \*\*Commercial fuel reprocessing plant

###

**Related NCI materials and Web pages:**

[Radioactive I-131 from Fallout Web Page](http://www.cancer.gov/cancertopics/causes/i131)  
 (<http://www.cancer.gov/cancertopics/causes/i131>)

**How can we help?**

We offer comprehensive research-based information for patients and their families, health care 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/live>
- 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-CA
- Get help** with quitting smoking at 1-877-44U-QUIT (1-877-448-7848)

<sup>1</sup>"Cancer Near Nuclear Installations," David Forman, Paula Cook-Mozaffari, Sarah Darb October 8, 1987.

[Questions About Cancer?](#)

**1-800-4-CANCER**

[LiveHelp Online](#)

[NCI Home](#) [Contact Us](#) [Policies](#) [Accessibility](#) [Viewing Files](#) [FOIA](#) [Site Help](#) [Site Map](#)

**Follow Us:** [Twitter](#) [YouTube](#) [Facebook](#) [RSS](#)

A Service of the National Cancer Institute

