Radon and Cancer

Florida study finds no evidence of increased risk

W.T. Vonstille Hildegarde L.A. Sacarello

Abstract

Residential radon levels from a statewide survey in Florida were used in an analysis of more than 150,000 malignancies and other serious illnesses and conditions medically treated in all counties in the state. No evidence of an increased percentage of cancer was found in people from the areas with the highest radon exposure levels. Among malignant neoplasms, lung cancers were relatively less frequent in males with the highest radon exposures and only slightly more frequent in females when compared to those unexposed. The average health risks of radon in Florida have been vastly overstated.

The percentages of cancer versus other diseases and conditions requiring medical treatment, analyzed by levels of radon exposure, were expected to provide health hazard evidence for the claim that "20,000 annual lung cancer deaths may be due to U.S. exposures to radon" (3). It has been suggested that up to 20% of U.S. lung cancers may be caused by radon, but this claim has been untested — even though evidence from health studies has identified cigarette smoking, asbestos exposure and urban air pollution as major causes of lung cancer.

The recent National Institute of Health atlas of cancer rates by U.S. counties raises further etiological doubts about radon as a carcinogen by showing that lung cancer death rates are highest in and near the major industrial centers along the eastern and Gulf coasts, the lower Mississippi River and other urban areas. Elevated rates of lung cancer do not occur in the radon areas of the Appalachian and Rocky Mountains, nor in the radon belts of Central Florida (2).

In general terms, this information raises additional doubts and suggests that the role of radon exposure in causing cancer may be small. Hence, specific health studies of human cancers and radon levels are urgently required to replace the crude health risk extrapolations made from high exposure mining occupations to living conditions for the vast majority of the population.

Radon and health data

In 1985 the Florida legislature commissioned a statewide survey of radon exposures. A summary of the final report was obtained from the Florida Institute of Phosphate Research in Bartow, Fla. (1). Radon risks were categorized from indoor and outdoor measurements, and the findings were summarized by quadrangles of the U.S. Geological Survey maps.

About 6,500 homes and one or two school buildings per county were selected for inside radon measurements. Outdoor gamma radiation and aerial radiation measurements from the National Uranium Resource Evaluation were used to produce an index of possible radon exposure. Definite evidence of elevated radon potential was found in 18 counties; limited evidence in 14 counties; and no evidence of an elevated radon potential was found in 35 counties.

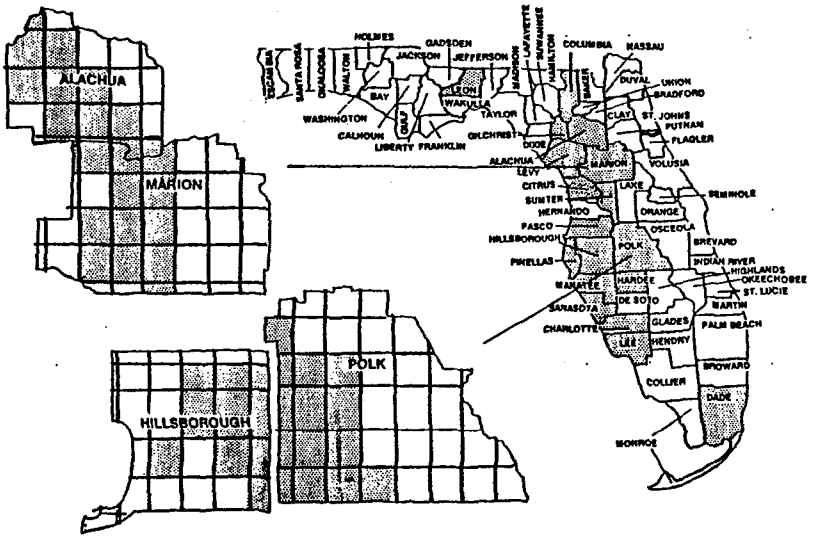
Figure 1 shows the Florida counties with elevated radon levels (1). Four of these counties, Alachua, Hillsborough, Marion and Polk, were further described as having the highest radon levels. From 5% to 22% of the homes sampled within each of these four counties were found to have radon levels above the U.S. Environmental Protection Agency action standard of 4 pico Curies of radon per liter of air (4).

Within these counties, the survey noted the U.S. Geological Survey quadrangles with the highest radon levels. These are indicated by shading in Figure 1. People living in the shaded quadrangles in the four highest radon counties could be expected to have the highest radon exposures in the state and are designated as the "Highest Radon" exposure group.

Health information was obtained from the data base of serious illnesses and conditions from all localities throughout the Southeast operated jointly by Health Accounting/Assessment, Inc., and the College of Health, University of Central Florida. All diseases and conditions were diagnosed by physicians according to the

Figure 1

Radon levels in Florida. Shading shows the counties with the highest levels and the highest radon locations within the four counties with the highest levels.



W.T. Vonstille, Environmental Health Analyst, Health Accounting/Assessment, Inc., Casselberry, FL 32718-0484; and Professor, College of Health, University of Central Florida, Orlando, FL 32816.

International Classification of Disease (ICD) coding recommendations and an episode of serious illness was defined as requiring one or more days of bed rest, hospitalization or both.

For this analysis, outcome information (such as a return to normal activities, limited or permanent disability or death) was not required. Age, sex and zip code information was obtained. Florida data were extracted for analysis according to the level of radon exposure. Episodes were excluded from analysis if there were missing data items or if the ICD code indicated normal deliveries and child births (in the absence of pathology, no effect of radon was expected). A total of 92,056 female and 64,528 male episodes of serious illness conditions were available for analysis.

Table 1

Severe Illnesses and Conditions by Radon Exposure

Males

Radon Level	Highest		Low		None	
Total, all ages						
Infections	160	5.6%	2,006	4.6%	839	4.7%
Malignant neoplasms	112	3.9%	2,359	5.4%**	638	3.6%
Benign neoplasms	11	0.4%	204	0.5%	86	0.5%
Metabolic-blood	139	4.9%	1,959	4.5%	850	4.8%
Mental conditions	279	9.8%	4,183	9.5%	1,647	9.3%
Nervous system	115	4.0%	1,244	2.8%	678	3.8%
Circulatory system	397	13.9%	8,842	20.1%	3,788	21.3%
Respiratory system	462	16.2%	4,684	10.7%	2,258	12.7%
Digestive system	286	10.0%	4,150	9.5%	1,340	7.5%
Genito-urinary system	83	2.9%	2,343	5.3%	592	3.3%
Skin conditions	56	2.0%	850	1.9%	373	2.1%
Musculo-skeletal	70	2.4%	1,739	4.0%	773	4.4%
Congenital-birth	209	7.3%	2,264	5.2%	1,096	6.2%
Symptoms, etc.	191	6.7%	2,719	6.2%	1,015	5.7%
Injuries	203	7.1%	3,005	6.8%	1,220	6.9%
Poisoning, etc.	85	3.0%	1,354	3.1%	567	3.2%
Total all conditions	2,858	100.0%	43,910	100.0%	17,760	100.0%

Females

Radon Level	Highest		Low		None	
Total, all ages						
Infections	163	3.3%	1,932	3.0%	664	3.0%
Malignant neoplasms	117	2.4%	2,867	4.4%**	646	2.9%
Benign neoplasms	50	1.0%	1,126	1.7%	236	1.1%
Metabolic-blood	239	4.9%	3,098	4.8%	1,184	5.3%
Mental conditions	423	8.6%	5,833	9.0%	1,933	8.6%
Nervous system	132	2.7%	1,515	2.3%	611	2.7%
Circulatory system	454	9.3%	9,357	14.5%	2,914	13.0%
Respiratory system	491	10.0%	5,361	8.3%	2,116	9.4%
Digestive system	343	7.0%	6,194	9.6%	1,761	7.8%
Genito-urinary system	279	5.7%	4,708	7.3%	1,378	6.1%
Pregnancy complitns.	1,294	26.5%	9,308	14.4%	4,386	19.5%
Skin conditions	64	1.3%	1,004	1.6%	356	1.6%
Musculo-skeletal	117	2.4%	2,151	3.3%	858	3.8%
Congenital-birth	175	3.6%	2,162	3.3%	718	3.2%
Symptoms, etc.	240	4.9%	3,605	5.6%	1,238	5.5%
Injuries	177	3.6%	2,835	4.4%	842	3.8%
Poisoning, etc.	134	2.7%	1,661	2.6%	606	2.7%
Total all conditions	4,892	100.0%	64,717	100.0%	22,447	100.0%

** Maximum percentage of cancers.

To estimate radon exposure, the zip code of each illness episode was matched to the zip codes of the statewide radon survey maps and the radon level determined. U.S. Post Office zip codes for Florida were located in U.S. Geological Survey quadrangles and classified as high, low or having no radon hazard potential.

Of the 3,000 zip codes assigned to Florida, 99 were located in the highest radon exposure quadrangles of the four counties with the highest radon levels; 918 zip codes were located in counties with no radon hazard potential (under .2 pico Curies per liter or .001 WL); and 1,983 zip codes were found in the low or intermediate radon level quadrangles.

The records were classified by computer into radon exposure categories and summarized by major disease groups as shown in Table 1. Since studies of atom bomb and other radiation survivors reported higher rates of a variety of cancers and leukemia in various age groups, lung cancers and all malignant neoplasms were grouped together for analysis.

Our study compares the percentages of malignant neoplasms by radon exposure levels. If higher radon exposure causes more lung or other cancers, then the percentages of lung cancer and other malignant neoplasms would be greatest in people with high radon exposure and the lowest percentages would be found in those unexposed.

Results

Table 1 shows that for both men and women, the percentages of malignant neoplasms were very similar regardless of radon exposure. Women from the highest radon exposure areas had the lowest percentages of cancers. The percentages of the other major groups of diseases are very similar from one radon exposure to the next and without a pattern suggesting a hazard.

These findings remained after limiting the analysis to less affluent people in each county, to reduce the effects of recent emigration, and after age adjustments to the 1985 Florida population as a standard: analytical alternatives did not affect the above interpretations.

Figures 2 and 3 show the percentages of malignant neoplasms in males and females by 10-year age groups. In Figure 2 (males) the solid line for high radon exposure repeatedly rises above and falls below the dotted line for the no radon exposure group. The dashed line for low radon exposures tends to be slightly above the other groups.

In Figure 3 (females) the dashed line for low radon exposure localities shows that malignant neoplasms comprised a higher percentage in all but the very youngest age

group. From age group to age group, the highest radon exposed females, shown by the solid line, tended to have lower percentages of malignant neoplasms than the no radon exposure group.

Table 2 summarizes the finding for respiratory cancers and leukemia. In males, lung cancers were relatively less common with increasing radon exposure levels. In females, lung cancers were relatively more common at high radon levels but this finding was offset by less lung cancer found at low radon levels than among people from areas of no exposure. Similarly, no pattern suggesting increased risk with increased exposure is apparent for other respiratory cancers and leukemia.

During the past 100 years, a higher frequency of lung cancer deaths has been associated with many kinds of mining; recent investigations with test animals have implicated radon decay daughters as possible causative agents. In a study of uranium mining in the western United States, measurements of alpha radiation from radon daughters were used in a unit of exposure called a Working Level, and a month of exposure was called a Working Level Month, WLM. WLM units are added and accumulated for individual miners exposed to varying radiation levels in different mining tasks and used to estimate health risks of cancer.

Uranium miners in the course of a lifetime of work may accumulate several thousand WLMs of exposure — many were found to be in the range of 500 to 4,000 WLMs of exposure. In comparison, since radon is present worldwide in the air, 70 years of life at the background rate (.004 WL) of exposure would produce a total lifetime exposure of 3.4 WLMs. In their report on uranium miners, Wagoner, et al

Table 2

Respiratory Malignant Neoplasms and Leukemia by Radon Exposure

Radon Level	Highest		Low		None	
Males: 3,110						
MN oropharynx	0	0.0%	6	0.3%	0	0.0%
MN nasopharynx	0	0.0%	3	0.1%	1	0.2%
MN hypopharynx	1	0.9%	6	0.3%	5	0.8%
MN nasal cavities	0	0.0%	3	0.1%	1	0.2%
MN larynx	9	8.0%	31	1.3%	7	1.1%
MN lung	14	12.5%	420	17.8%	120	18.8%
Lymphoid leukemia	6	5.4%	47	2.0%	29	4.5%
Myeloid leukemia	8	7.1%	64	2.7%	30	4.7%
Other leukemia	1	0.9%	0	0.0%	2	0.3%
Other leukemia unspec.	1	0.9%	19	0.8%	8	1.3%
All other malignanices	72	64.3%	1,760	74.6%	464	72.7%
Total	112	100.0%	2,359	100.0%	638	100.0%
Females: 3,630						
MN nasopharynx	0	0.0%	2	0.1%	7	1.1%
MN hypopharynx	0	0.0%	2	0.1%	3	0.5%
MN oral, unspecified	0	0.0%	0	0.0%	2	0.3%
MN nasal cavities	0	0.0%	2	0.1%	0	0.0%
MN larynx	1	0.9%	12	0.4%	4	0.6%
MN lung	17	14.5%	265	9.2%	86	13.3%
Lymphoid leukemia	2	1.7%	49	1.7%	10	1.5%
Myeloid leukemia	7	6.0%	38	1.3%	9	1.4%
Monocytic leukemia	0	0.0%	2	0.1%	0	0.0%
Other leukemia	0	0.0%	1	0.0%	0	0.0%
Other leukemia unspec.	0	0.0%	20	0.7%	1	0.2%
All other malignancies	90	76.9%	2,474	86.3%	524	81.1%
Total	117	100.0%	2,867	100.0%	646	100.0%

Figure 2

Percentages of male malignancies among serious illnesses and conditions by radon exposures, Florida, 1987-88.

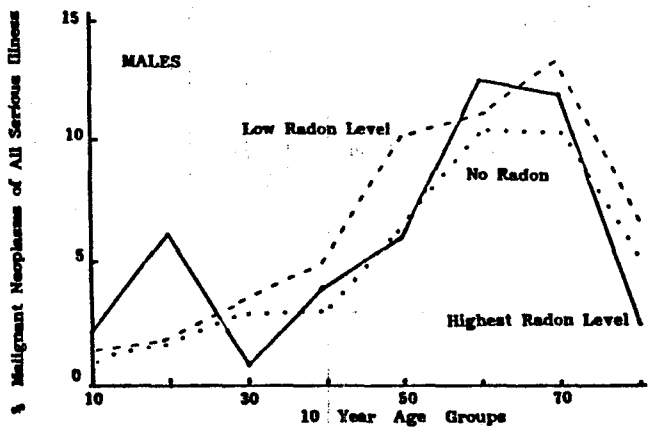
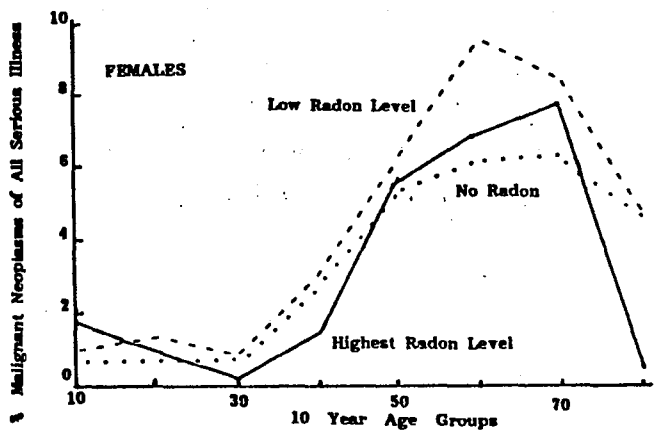


Figure 3

Percentages of female malignancies among serious illnesses and conditions by radon exposures, Florida, 1987-88.



(5), show that one lung cancer death per year was expected among every 1,000 miners with 1,000 WLMs of exposure.

Exposure for one month to the EPA action standard of 4 pico Curies of radon gas per liter of air, is equivalent to .02 WLMs (4) in uranium mining. A lifetime exposure of 70 years at this level would produce a cumulative total of about 17 WLMs or 8.5 WLMs, as an average, during life.

If even one-quarter of the people in the highest radon areas of Florida had an average exposure as high as the 4 pCi/L standard, and if the cancer rates in uranium mining applied to Florida conditions, the population with highest radon exposures would average about 2 WLMs per person and about 3 WLMs including background exposures. This might cause .3 male and .08 female lung cancers per 100,000.

The current U.S. lung cancer rates are 61.8 for males and 15.5 for females per 100,000 people (2), so the upper percentage limit for lung cancers that may be caused by the highest radon exposures occurring in Florida might be less than 1.0% of the total rates. An upper limit of a 1% increase in lung cancer risks confined to the highest radon areas of Florida is vastly less than the claimed 20% of lung cancers that may be due to radon.

Conclusions

Since 1986 the U.S. Department of Energy and the EPA have publicized their claim that up to 20,000 lung cancer deaths each year may be due to exposure to radon; our analysis of illnesses by radon levels throughout Florida fails to find support for this claim.

Since 1986 the U.S. Department of Energy and the EPA have publicized their claim that up to 20,000 lung cancer deaths each year may be due to radon exposure; our analysis fails to find support for this claim.

We reviewed more than 150,000 malignancies and other serious illnesses in all parts of the state. People in localities with the highest radon levels have a lower percentage of malignant neoplasms compared to people from areas with no radon exposure risks.

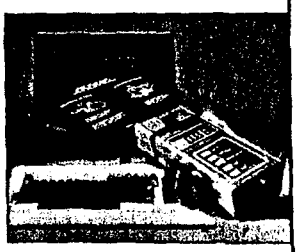
Our findings are consistent with the NIH cancer atlas showing that U.S. lung cancer death rates are highest in industrial areas and not in high radon areas. Extrapolation of lung cancer rates of radon exposures in uranium miners to the highest radon exposure areas of Florida further indicates a very small average lung cancer risk — as found in our environmental health analysis.

References

1. Florida Institute of Phosphate Research (1987), *Florida Statewide Radiation Study, Summary of Final Report*, Florida Institute of Phosphate Research, Bartow, Fla.
2. Pickle, L.W., T.J. Mason, N. Howard, R. Hoover and J.F. Fraumeni (1987), *Atlas of U.S. Cancer Mortality Among Whites: 1950-1980*, U.S. DHHS Publication No. (NIH) 87-2900
3. U.S. Department of Energy (1986), *Indoor Air Quality Environmental Information Handbook: Radon*, Washington, D.C.
4. U.S. Environmental Protection Agency (1986), *A Citizen's Guide to Radon*, Report OPA-86-004, Washington, D.C.
5. Wagoner, J.K., V.E. Archer, F.E. Lundin, D.A. Holaday and J.W. Lloyd (1965), Radiation as the Cause of Lung Cancer Among Uranium Miners. *N. Eng. J. Med.* 273:1181-188

NON-IONIZING RADIATION TEST EQUIPMENT

HI-3600-01 VDT Radiation Survey Meter
Easy to use. Measures electric and magnetic fields surrounding VDT or CRT's in the office or work areas. Frequency range of 10KHz to 300 KHz.
Sensitivity Range:
E–Field = 1 V/M to 2000 V/M.
H–Field = 1 ma/M to 2 A/M.



HI-3600-02 ELF/Power Frequency EMF Survey Meter
Measurements in home and industrial environments of power frequency electric and magnetic fields from electric power lines (50 - 60 Hz).
Sensitivity Range:
E–Field = 1 V/M to 200 KV/M.
H–Field = 1 ma/M to 200 A/M.

For more information, please call or write:

HOLADAY INDUSTRIES, INC.
14825 Martin Drive
Eden Prairie, MN 55344
Telephone: (612) 934-4920
Telex: 29-0922 Fax: (612) 934-3604

RADON GAS:
The Deadliest Pollutant.

"We consider Radon the most significant health risk today."
Assistant Surgeon General

"At least one in five homes may have higher than recommended levels of Radon."
American Lung Association

"The only way to know if you have a Radon problem is to test your home."
Federal Environmental Protection Agency

You Can Test Your Own Home Yourself.
You can discreetly test your own home for deadly Radon gas with a charcoal canister kit, the most widely used test for detecting the presence of Radon Gas.
Safe-Aire® Test Kits only $9.49 each. + $2 S&H
Price includes EPA approved laboratory analysis, test instructions, recommended follow-up proceedures, and Radon Mitigation Products catalog.

To order send check or money order for $11.49 to:

Safe-Aire® Inc.
162 East Chestnut • Canton, IL 61520

To Charge Your Order By Phone Call Toll-Free
1-800-331-2943
Call or write today for FREE Radon Mitigation Supply Catalog!