Radon And Lung Cancer In Ohio: A Research Note

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Abstract

Many substances can be harmful or even lethal in sufficiently high quantity but may be innocuous in low amounts. Previous research has shown harmful relationships between radon and lung cancer. Other research suggests either no relationship or a protective effect. Thus, further research is indicated on this topic. Using an ecological design, the present study compared average radon levels in Ohio counties to lung cancer death rates also by county. The study also compared land elevation to the death rates since previous research has revealed a protective relationship between it (land elevation) and lung cancer. The results of the present study did not reveal any statistically significant correlations between lung cancer death rates and radon or land elevation. A limitation to the study is that smoking rates by county were not included. Further study is warranted.

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INTRODUCTION

Many substances can be harmful or even lethal in sufficiently high quantity but may be innocuous in low amounts. Radon is considered a risk factor for lung cancer (1-2), even with levels as low as 1.3 pico curies per liter of air. (3) Other research suggests that radon is not necessarily a risk factor for lung cancer, at least in the state or Oregon, (4) and may even be protective against lung cancer. (5) As might be predicted, this latter view has been challenged. (6) Additional research suggests that land elevation may be inversely related to lung cancer, where decreased oxygen concentration at higher elevations may be associated with lower lung cancer rates. (7)

The present research note seeks to add to the body of knowledge on this topic (of radon and lung cancer), in Ohio, with a secondary consideration given to land elevation as a possible factor. This state was selected because its radon data by county (as a continuous variable) was found to be available online, which, in this author's view is unusual. No previous studies were found for Ohio on the topic of radon and lung cancer. The variable of smoking rates was not found to be available by county for Ohio and thus is a limitation to the study. However, it is suggested that radon alone (without smoking) is a cause of lung cancer: "Overall, radon is the second-leading cause of lung cancer." (3) Thus, it is assumed that if a relationship exists between radon and lung cancer, it should show up at least with a correlation analysis.

METHODS

Age-adjusted lung cancer death rates per 100,000 people were obtained from the National Cancer Institute for two race groups (since death rates tend to vary by race, and percents of race in the population tend to differ by geographic location): a) whites ("w") and b) non whites ("nw"). (8) For both race categories, the following was included for the lung cancer death rates: trachea, bronchus, lung, and pleura; both genders, all ages, for years 1990-2004, age-adjusted to 1970 U.S. population (2004 was the most recent year available at this database at the time of this study). For the w race category, all 88 counties were represented while 37 counties showed the death rates for the nw category (due to some counties not reporting data for this race due to sparse data and therefore were not included in this study).

Residential radon measurements (in picocuries per liter of air) for the 88 Ohio counties were obtained from a University of Toledo website. (9) The arithmetic mean radon metric was used for years 1986-2013 ("radon"). Thus, the years for radon measurements and death rates overlapped.

Since land elevation ("elevation") has been linked to lung cancer, as possibly having a protective effect via lower oxygen concentration at higher altitudes (7), it too was included in the study. Land elevation for each county was obtained from an interactive U.S. Geological Survey database. (10) Here, the geographic center of a county was identified using the “Get Elevation” tool. In the event elevation was automatically marked at a location that was obviously not the geographic center, the “Spot Elevation” tool was used, where the geographic center was estimated. There were two instances (out of 88 counties) where this occurred (Huron and Noble counties). There were two other instances where this occurred but their elevations were still used since the automatic locations were close to large metropolitan areas (Cleveland and Toledo, for Lake and Lucas counties respectively).

Probability plots (for determining normality of the individual variables) and scatter plots (for determining linear relationships between the variables) indicated that Pearson correlation was an appropriate statistical test to use for these data. Thus, using an ecological design, the death rates (for two race categories, lung-w and lung-nw) were correlated with: a) the radon measurements and b) elevation. Two-tailed p-values less than or equal to the conventional alpha level of 0.05 were considered statistically significant.

RESULTS

Table 1 shows raw and summary data. Average radon level for the Ohio counties was 6.9 pico curies per liter. All correlations between lung cancer death rates (for the two race groups) and: a) radon and b) elevation were weak-to-negligible in strength, and statistically non-significant (Table 2). Figures 1 and 2 show scatter plots for radon and the death rates for the two race categories and reveal a lack of linear correlation.

DISCUSSION

The average radon concentration in Ohio was about 3 pico curies per liter above the highest radon potential zone for radon maps at the U.S. Environmental Protection Agency. (11) Thus, radon appears to occur be in a relatively high concentration in Ohio. However, this study found essentially no correlation between it (radon) and lung cancer.

Elevation revealed slightly stronger correlations with lung cancer compared to radon, but again, these correlations (with elevation) were also weak and statistically non-significant. Perhaps if a larger sample size was used (e.g., combining counties from two or more states), the correlations may have been statistically significant. Previous research on altitude hypothesized that the mechanism for an apparent protective effect at higher altitudes pertained to decreased oxygen concentration. Another possibility is the purported protective effect against cancer that could also pertain to slight increases in cosmic radiation (as a component of low level background radiation) at higher elevations (12).

The study’s strengths include an accounting of race and age. It is limited by its (ecological) design, where individual exposures are unknown. However, the design can be considered as a strong point, in that entire populations are included. Another limitation to the study is that smoking rates by county were not included. However, as noted in the Introduction, some literature seems to suggest that radon alone, without other variables such as smoking, is a cause of lung cancer: “Overall, radon is the second-leading cause of lung cancer.” (3)

CONCLUSION

This preliminary study did not reveal any statistically significant correlations between radon and lung cancer for Ohio counties for the years analyzed. Further research on this topic is indicated to verify these findings, using other designs such as case-control.

Table 1

Raw and summary data for all variables in the study. Blanks in Lung-nw column = data not available due to data being sparse. n = number of counties. SD = standard deviation. Elevation = land elevation in feet above sea level. Radon = pico curies per liter. Lung w = lung cancer death rates for whites. Lung nw = lung cancer death rates for non whites. Blank cells (in Lung-nw column) are those where the cancer data was indicated as sparse in the source used (8) and therefore not used in this study.

County	Elevation	Radon	Lung-w	Lung-nw
Adams	858	4.84	65.74	
Allen	878	6.33	50.33	58.98
Ashland	1148	8.83	39.65	
Ashtabula	1000	4.09	53.07	40.93
Athens	763	4.85	60.77	
Auglaize	877	7.16	43.33	
Belmont	1161	6.96	55.12	52.88
Brown	951	3.10	66.59	
Butler	824	8.13	57.80	57.68
Carroll	1023	11.46	41.15	
Champaign	1060	9.83	50.17	59.05
Clark	1017	8.17	58.88	63.58
Clermont	745	4.96	65.66	70.86
Clinton	1086	5.38	51.83	93.98
Columbiana	1200	10.13	52.23	39.38
Coshocton	802	13.24	50.68	
Crawford	1044	6.48	48.93	
Cuyahoga	584	3.01	46.18	61.83
Darke	1033	8.16	38.75	
Defiance	708	3.71	45.40	
Delaware	951	7.48	42.12	39.65
Erie	616	6.71	54.07	62.51
Fairfield	1027	9.31	49.04	
Fayette	981	7.17	49.33	
Franklin	713	9.42	57.60	61.89
Fulton	775	3.98	35.35	
Gallia	659	2.72	54.14	
Geauga	1154	3.29	38.63	
Greene	997	7.27	49.47	49.96
Guernsey	1016	5.75	58.24	
Hamilton	679	3.43	54.83	71.35
Hancock	807	5.38	41.65	
Hardin	974	4.72	52.93	
Harrison	1159	17.12	64.86	
Henry	682	4.01	43.89	
Highland	963	4.59	52.70	
Hocking	896	9.92	61.03	
Holmes	1033	10.26	28.43	
Huron	881	10.94	48.06	
Jackson	662	3.57	62.13	
Jefferson	1058	10.31	59.25	62.81
Knox	963	23.96	46.52	
Lake	763	3.62	50.79	44.69
Lawrence	833	4.67	65.05	85.29
Licking	1055	17.99	57.37	61.81
Logan	1228	13.40	52.93	
Lorain	765	4.80	53.44	54.96
Lucas	627	3.79	55.12	61.58
Madison	1023	8.13	55.06	
Mahoning	1088	3.36	46.99	62.90
Marion	925	6.48	58.68	49.73

Table 1 Continued

Medina	1157	4.25	46.01	
Meigs	735	2.10	69.27	
Mercer	874	6.97	38.56	
Miami	889	8.28	47.10	66.48
Monroe	1094	5.53	45.72	
Montgomery	974	5.63	54.21	61.66
Morgan	668	4.99	52.40	138.87
Morrow	1195	7.45	54.29	
Muskingum	881	7.36	58.77	89.86
Noble	863	3.01	37.28	
Ottawa	583	4.92	43.96	
Paulding	725	3.50	52.54	
Perry	1004	8.90	62.45	
Pickaway	697	11.81	54.60	65.69
Pike	942	6.56	51.72	
Portage	1033	4.10	52.79	33.66
Preble	1042	7.64	49.12	
Putnam	725	6.21	35.14	
Richland	1287	9.14	48.56	63.01
Ross	687	9.73	61.80	55.87
Sandusky	630	6.55	45.30	62.35
Scioto	578	3.52	65.38	52.97
Seneca	794	7.81	48.29	
Shelby	1035	7.53	46.42	
Stark	1087	7.49	46.52	62.01
Summit	868	5.90	49.91	60.22
Trumbull	898	3.00	49.21	56.93
Tuscarawas	1101	9.38	43.82	
Union	1026	5.46	51.56	
Van Wert	779	5.62	38.60	
Vinton	857	3.04	63.52	
Warren	783	5.02	53.33	
Washington	617	4.69	53.04	
Wayne	1128	10.71	45.83	59.56
Williams	868	5.73	47.38	
Wood	664	4.30	45.78	
Wyandot	844	5.28	41.31	
n	88	88	88	37
Mean	901.4	6.9	51.1	62.1
SD	175.9	3.6	8.1	18.0
Minimum	578	2.1	28.4	33.7
Maximum	1287	24.0	69.3	138.9

Table 2

Correlations and their corresponding p-values.

Variable 1	Variable 2	Correlation	p-value
Lung w	Elevation	-0.122	0.26
Lung w	Radon	-0.029	0.79
Lung nw	Elevation	-0.226	0.18
Lung nw	Radon	-0.060	0.73

Lung w = lung cancer death rates for whites. Lung nw = lung cancer death rates for non whites.

Figure 1

Scatter plot for white lung cancer death rates (per 100,000, 1990-2004) versus radon (pico curies per liter, 1986-2013). Each dot represents a county in Ohio.

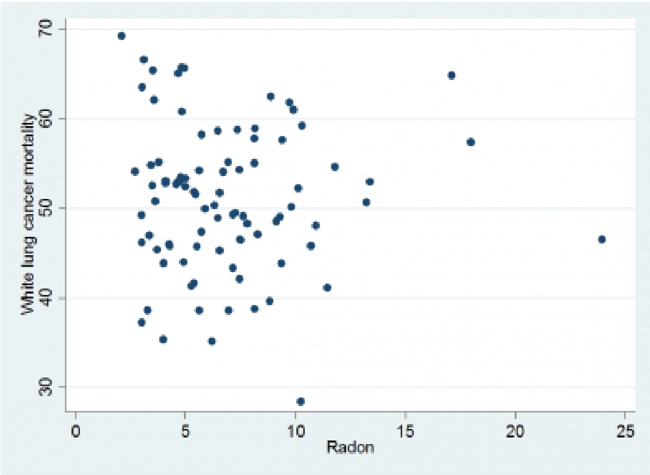
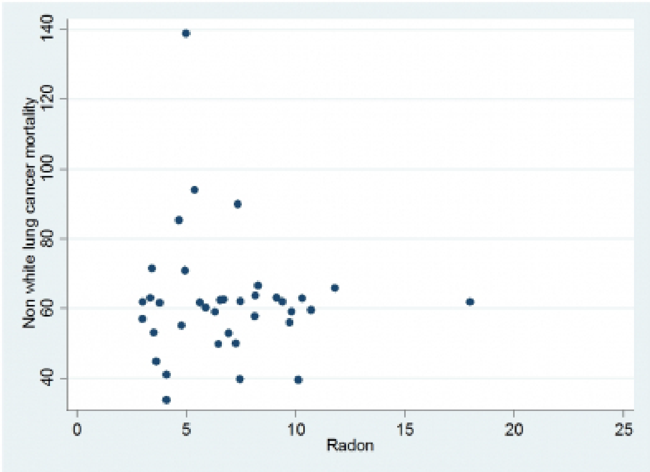


Figure 2

Scatter plot for non white lung cancer death rates (per 100,000, 1990-2004) and radon (pico curies per liter, 1986-2013). Each dot represents a county in Ohio.



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