In-door Radon Gas, Cigarette Smoking and Canser Prevelance

[*1]Cemil Örgev [2]Sinan Serdar Özkan [3]İsmail Gümüş
[*1]Sakarya Vocational High School, Environmental Protection Technology, Sakarya University, Turkey
[2]Faculty of Technology, Department of Mechatronic Engineering Sakarya University, Turkey
[3]Sakarya Vocational High School, Accounting and Tax Issues, Sakarya University, Turkey

Abstract

Community defined critical thinking as "the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action. In this study, measured in-door Radon Gas Exposure Values evaluated by Turkey Atom Energy Institution and the relationships among the radon gas values, cigarette smoking and censer prevalence will be investigated. In addition, the measurement locations and earthquake fault line relationship; the buildings in which the measurements carried out and the smoking habits of households will be respectively researched. It is going to be criticized whether there is a significant relationship among radon gas levels cigarette smoking and cancer cases.

Key words: Critical thinking, Radon gas, Earthquake, Cigarette smoking, Cancer prevalence

1. Introduction

In this study, firstly, the critical thinking and creativity; secondly, using the critical thinking and creativity concepts, the relationship among cigarette smoking, radon gas, cancer and earthquake is researched.

1.1.Critical thinking and creativity

Critical thinking can be defined as being able to examine an issue by breaking it down, and evaluating it in a conscious manner, while providing arguments/evidence to support the evaluation [1]. Creativity is ability, an attitude, and a process [2]. Creativity is the ability to imagine or invent something new, and the ability to generate new ideas by combining, changing, or reapplying existing ideas. It is an attitude, the ability to accept change and newness, a willingness to play with ideas and possibilities, a flexibility of outlook, the habit of enjoying the good, while looking for ways to improve it. And it is also a process, in which creative people work hard and continually to improve ideas and solutions, by making gradual alterations and refinements to their works.

*Corresponding author: Address: Sakarya Vocational High School, Department of Environmental Protection Technology, Sakarya University, 54100, Sakarya TURKEY. E-mail address: corgev@sakarya.edu.tr, Phone: +902642957462

1.2.Radon, cigarette smoking, lung cancer

In order to get enough knowledge about the relationship among the radon gas, cigarette smoking, cancer, and earthquake, the national and international literature scanning is carried out.

1.2.1. Radon Gas

Radon gas is produced by decay of uranium in soil and enters homes via cracks in floors and foundation walls, or slab openings for sump pumps and plumbing. The gas has no color, odor or taste and as a result exposure can occur for many years without a person suspecting its presence. In this way, it is unlike other home pollutants such as carbon monoxide, where health effects are felt shortly after initial exposure. Radon is produced in virtually every type of soil or rock, but particularly high levels often occur where there are large deposits of limestone, granite, sandstone, shale and clays [3]. The element radon, a noble gas with atomic number 86, is carcinogenic because of its smaller radioactive decay particles called radon progeny [4]. These fine, solid particles are inhaled; they attach to the lungs' inner lining, accumulate over time, and continue to decay into smaller products. The decay products create free radicals and damage DNA. Radon is a chemical element with symbol Rn and atomic number 86. It is a radioactive, colorless, odorless, tasteless, noble gas, occurring naturally as an indirect decay product of uranium or thorium. Its most stable isotope, 222Rn, has a half-life of 3.8 days [5]. Radon is one of the densest substances that remain a gas under normal conditions. It is also the only gas under normal conditions that only has radioactive isotopes, and is considered a health hazard due to its radioactivity. Intense radioactivity has also hindered chemical studies of radon and only a few compounds are known. Radon gets in through these parts of your home: cracks in solid floors, construction joints, cracks in walls, gaps in suspended floors, gaps around service pipes, cavities inside walls, and the water supply.

Radon is a noble gas, which means it is basically *inert* (does not combine with other chemicals). Radon is a heavy gas and tends to collect in basements or other low places in housing. It has no color, odor, or taste. Radon-222 is produced by the decay of radium, has a half-life of 3.8 days, and emits an alpha particle as it decays to polonium-218, and eventually to stable lead. Radon-220, is the decay product of thorium – it is sometimes called thoron, has a half-life of 54.5 seconds and emits an alpha particle in its decay to polonium-216. The figure 1 below provides an overview of the uranium-238 decay chain. Radon is part of that decay chain and is produced by the radioactive decay of radium.

Radon has been considered the second leading cause of lung cancer and leading environmental cause of cancer mortality by the United States Environmental Protection Agency [6]. Radon is a colorless, odorless natural gas. Radon is produced by the radioactive decay of radium-226, which is that 2,400 million curies (90 TBq) of radon are released from soil annually [7]. Radon is a radioactive gas that emanates from rocks and soils and tends to concentrate found in uranium ores; phosphate rock; shales; igneous and metamorphic rocks such as granite, gneiss, and schist; and, to a lesser degree, in common rocks such as limestone[8].

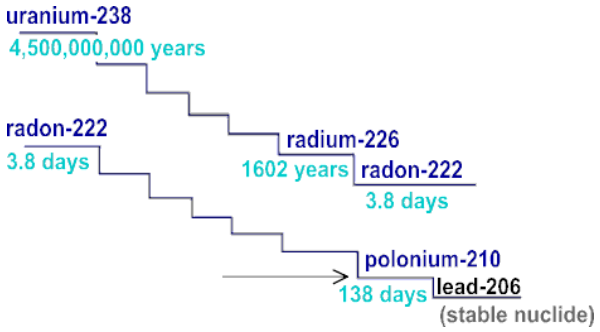

Figure 1. The Uranium-238 to Radon 222 Decay Chain

Every square mile of surface soil, to a depth of 6 inches (2.6 km2 to a depth of 15 cm), contains approximately 1 gram of radium, which releases radon in small amounts to the atmosphere [9]. On a global scale, it is estimated in enclosed spaces like underground mines or houses. The parts of a home radon gets in through are given in figure 2 below [10]. Radon gets in through: cracks in solid floors, construction joints, cracks in walls, gaps in suspended floors, gaps around service pipes, cavities inside walls, and the water supply.

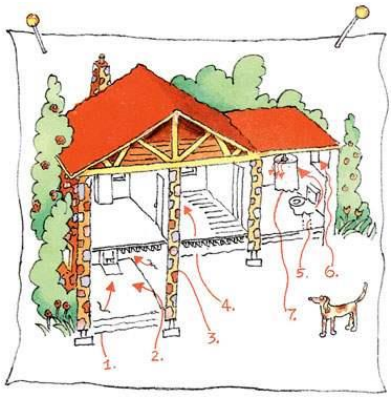

Figure 2. The parts of a home radon gets in through

Radon has been classified as a known human carcinogen and has been recognized as a significant health problem by groups such as the Centers for Disease Control, the American Lung Association, the American Medical Association, and the American Public Health Association. The U.S. Environmental Protection Agency (EPA) updates its assessment of health risks from indoor radon, which the National Academy of Sciences (NAS) has determined to be the second leading cause of lung cancer after cigarette smoking. Radon is a radioactive gas that has been found in homes all over the United States. It comes from the natural breakdown of uranium in soil, rock and water and gets into the air you breathe. Radon typically moves up through the ground to the air above and into your home through cracks and other holes in the foundation. Radon can also enter your home through well water. Your home can trap radon inside [10]. The National Research Council's BEIR VI Committee estimates that residential radon - 222 (radon) decay product exposure causes between 3000 and 38,600 lung cancer deaths per year in the United States [11].

1.2.2. Cigarette Smoking

The adverse health effects of cigarette smoking are well established and include lung cancer (LC), chronic obstructive pulmonary disease (COPD) and cardiovascular disease (CVD) [12,13,14]. The health benefits of quitting smoking are also well documented [13,15]. It is well known that the main cause of lung cancer among smokers is their cigarettes, but unbeknownst to many is that this cancer develops in a large number of nonsmokers. The leading cause of lung cancer for nonsmokers is exposure to radon in the home. According to the World Health Organization (WHO), 3-14% of lung cancer cases are caused by low- and medium-level exposure to radon in homes [16]. The tobacco leaves used in making cigarettes contain radioactive material, particularly lead-210 and polonium-210. When phosphate fertilizer is spread on tobacco fields year after year, the concentration of lead-210 and polonium-210 in the soil rises. The radionuclide content of tobacco leaves depends heavily on soil conditions and fertilizer use. Tar from tobacco smoke builds up there, and traps lead-210 and polonium-210 against the sensitive tissues of the bronchioles.

1.2.3. Radon gas and lung cancer

Smoking combined with radon is an especially serious health risk. If you smoke or are a former smoker, the presence of radon greatly increases your risk of lung cancer. If you stop smoking now and lower the radon levels in your house, you will reduce your lung cancer risk. Radioactive radon is an inert gas that can migrate from soils and rocks and accumulate in enclosed areas, such as homes and underground mines.
According to the EPA, the risk of lung cancer for smokers is significant due to synergistic effects of radon and smoking. For this population about 62 people in a total of 1,000 will die of lung cancer compared to 7 people in a total of 1,000 for people who have never smoked. It can, however, not be excluded that the risk of non-smokers should be primarily explained by a combination effect of radon and passive smoking. Radon, like other known or suspected external risk factors for lung cancer, is a threat for smokers and former smokers. This was clearly demonstrated by the European pooling study [17] A commentary to the pooling study stated [18]: "it is not appropriate to talk simply of a risk from radon in homes. The risk is from smoking, compounded by a synergistic effect of radon for smokers. Without smoking, the effect seems to be so small as to be insignificant. According to the European pooling study, there is a difference in risk from radon between histological types. Small cell lung carcinoma, which practically only affects smokers have high risk from radon. For other histological types such as adenocarcinoma, the type that primarily affects never smokers, the risk from radon appears to be lower [19].

Any home can have a radon problem. This means new and old homes, well-sealed and drafty homes, and homes with or without basements. In fact, you and your family are most likely to get your greatest radiation exposure at home. That is where you spend most of your time. Nearly 1 out of every 15 homes in the United States is estimated to have an elevated radon level (4 pCi/L or more). Radon measurement will give you an idea of your risk of getting lung cancer from radon. Home's radon level chances of getting lung cancer from radon depend mostly on home's radon level, the amount of time you spend in your home, and whether you are a smoker or have ever smoked. Smoking combined with radon is an especially serious health risk. If you smoke or

are a former smoker, the presence of radon greatly increases your risk of lung cancer. If you stop smoking now and lower the radon levels in your house, you will reduce your lung cancer risk.
At an individual level, the risk of radon-induced lung cancer following exposure to a given radon concentration is much higher among current cigarette smokers than among lifelong non-smokers. This has been illustrated by the pooled analysis of European residential radon studies [19]. For lifelong non-smokers, it was estimated that living in a home with an indoor radon concentration of 0,100 or 800 Bq/m^3 was associated with a risk of lung cancer death (at the age of 75) of 4,5 or 10 in a 1 000, respectively. However, for a cigarette smoker, each of these risks would be substantially greater, namely 100, 120 and 220 in 1000. For those having stopped smoking, the radon-related risks are substantially lower than for those who continue to smoke, but they remain considerably higher than the risks for lifelong non-smokers [20]. Radon risk if you've never smoked Table 1, and radon and smoking: radon risk if you smoke Table 2, are given below.

Table 1. Radon Risk If You've Never Smoked

Radon Level	If 1,000 people who never smoked were exposed to this level over a lifetime*...	The risk of cancer from radon exposure compares to**...	WHAT TO DO:
20 pCi/L	About 36 people could get lung cancer	35 times the risk of drowning	Fix your home
10 pCi/L	About 18 people could get lung cancer	20 times the risk of dying in a home fire	Fix your home
8 pCi/L	About 15 people could get lung cancer	4 times the risk of dying in a fall	Fix your home
4 pCi/L	About 7 people could get lung cancer	The risk of dying in a car crash	Fix your home
2 pCi/L	About 4 person could get lung cancer	The risk of dying from poison	Consider fixing between 2 and 4 pCi/L
1.3 pCi/L	About 2 people could get lung cancer	(Average indoor radon level)	(Reducing radon levels below 2 pCi/L is difficult.)
0.4 pCi/L		(Average outdoor radon level)	

Note: If you are a former smoker, your risk may be higher.

* Lifetime risk of lung cancer deaths from EPA Assessment of Risks from Radon in Homes (EPA 402-R-03-003).

** Comparison data calculated using the Centers for Disease Control and Prevention's 1999-2001 National Center for Injury Prevention and Control Reports.

Table 2. Radon and Smoking: Radon Risk If You Smoke

Radon Level	If 1,000 people who smoked were exposed to this level over a lifetime*...	The risk of cancer from radon exposure compares to**...	WHAT TO DO: Stop smoking and...
20 pCi/L	About 260 people could get lung cancer	250 times the risk of drowning	Fix your home
10 pCi/L	About 150 people could get lung cancer	200 times the risk of dying in a home fire	Fix your home
8 pCi/L	About 120 people could get lung cancer	30 times the risk of dying in a fall	Fix your home
4 pCi/L	About 62 people could get lung cancer	5 times the risk of dying in a car crash	Fix your home
2 pCi/L	About 32 people could get lung cancer	6 times the risk of dying from poison	Consider fixing between 2 and 4 pCi/L
1.3 pCi/L	About 20 people could get lung cancer	(Average indoor radon level)	(Reducing radon levels below 2 pCi/L is difficult.)
0.4 pCi/L	About 3 people could get lung cancer	(Average outdoor radon level)	

Note: If you are a former smoker, your risk may be lower.

* Lifetime risk of lung cancer deaths from EPA Assessment of Risks from Radon in Homes (EPA 402-R-03-003).

** Comparison data calculated using the Centers for Disease Control and Prevention's 1999-2001 National Center for Injury Prevention and Control Reports.

2. Method

The study design has three major components: 1) literature scanning 2) reanalysis of the collected data in accordance with the critical thinking concept, 3) seeking the cigarette smoking, radon gas amount and cancer relations by using a questionnaire consisting of 9 questions. This phase of the study was carried out face to face interviews with 93 households. Critically some hypotheses created to eradicate the relations among asked questions. The questionnaire results were evaluated by SPSS 17 using T-Tests, Anova Tests, and Chi-Square Tests.

3. Results

According to the American Lung Association, there are about 48 million adult smokers in the U.S., and 4.8 million adolescent smokers. Smoking is the number one cause of preventable death in the U.S., with 443,000 deaths, or 1 of every 5 deaths, in the United States each year. And, there are 123,000 lung cancer deaths annually attributed to smoking cigarettes. Nearly 1 of every 5 deaths is related to smoking, more than alcohol, car accidents, suicide, AIDS, homicide, and illegal drugs combined. The concentration of lead-210 and polonium-210 in tobacco leaf is

relatively low; however, this low concentration can accumulate into very high concentrations in the lungs of smokers. As it passes into the lungs, the smoke impacts the branches of the lung passages, called bronchioles, where the branches split. Tar from tobacco smoke builds up there, and traps lead-210 and polonium-210 against the sensitive tissues of the bronchioles.

The meaningfully resulted hypotheses are:

Hypothesis 1: There is a positive relation between the questions "Is there any smoker in the family?" and the question " is there a diagnosed disease with the cigarette smoking people in the family over the last 15 years?". The resultsare given below in table 3 T-Test Group Statistics and table 4 Independent Samples Test.

Table 3. Group Statistics

	1 Is there any smoker in the family?	N	Mean	Std. Deviation	Std. Error Mean
6. "Do you have a smoker diagnosed with a chronic disease in the family over the last 15 years?"	Yes	57	4,47	1,151	,152
	No	35	4,89	,676	,114

Table 4. Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
		Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
6. "Do you have a smoker diagnosed with a chronic disease in the family over the last 15" years?	Equal variances assumed	17,884	,000	-1,921	90	,058	-,412	,214	-,838	,014
	Equal variances not assumed			-2,162	89,875	,033	-,412	,191	-,791	-,033

Hypothesis 2: There is a positive relation between the questions "is there a diagnosed chronic disease with the cigarette smoking people in the family?" and the question "The amount of cigarette consumption by smokers in family?". The meaningful result is given in table 5 by ANOVA test.

Table 5. ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11,203	4	2,801	2,963	,024
Within Groups	82,232	87	,945		
Total	93,435	91			

Hypothesis 3. There is a positive relation between the questions "Are there any family members suffering from a chronic disease over last 15 years?" and the question "What is the amount of daily cigarette consumption by smokers in family?". The results are given in table 6 Chi-Square Test and table 7 as Crosstabulation.

Table 6. Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17,077[a]	8	,029
Likelihood Ratio	9,574	8	,296
Linear-by-Linear Association	,059	1	,808
N of Valid Cases	92		

a. 10 cells (66,7%) have expected count less than 5. The minimum expected count is ,11.

Table 7. Crosstabulation

		7. What is the amount of daily cigarette consumption?					Total
		A half packet	A packet	One and a half packet	Two packet and more than	no	
3. Are there any family members suffering from a chronic disease over last 15 years?	0	0	0	2	0	0	2
	Yes	3	19	5	4	22	53
	No	2	13	3	4	15	37
Total		5	32	10	8	37	92

Hypothesis 4. There is a meaningful relation between the questions "is there a diagnosed chronic disease with the cigarette smoking people in the family? and "The amount of daily cigarette consumption by smokers in family?". It is given in Table 8a and b by Chi-Square Tests below.

Table 8.a. Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	44,887[a]	20	,001
Likelihood Ratio	30,504	20	,062
Linear-by-Linear Association	2,424	1	,119
N of Valid Cases	92		

a. 26 cells (86,7%) have expected count less than 5. The minimum expected count is ,05.

Table 8.b. Chi-Square Test

		7 What is the amount of daily cigarette consumption?					Total
		A half packet	A packet	One and a half packet	Two packet and more than	No	
6. Do you have a smoker diagnosed with a chronic disease in the family over the last 15 years?	Cardio vascular	0	1	1	0	0	2
	Shortness of breath	0	4	1	1	1	7
	Hypertension	0	0	2	0	0	2
	Shortness of breath and Hypertension	0	0	1	1	0	2
	No	5	27	5	5	36	78
	Shortness of breath and heart	0	0	0	1	0	1
Total		5	32	10	8	37	92

Conclusions

It is determined that a study is scheduled to be completed within the next 5 years under the leadership of the Ministry of Health and The Turkish Atomic Energy Institution. The Turkish Statistical Institution has selected 62320 houses representing 81 provinces in Turkey, by using scientific method. The residential radon gas measurements haven't been evaluated by The Turkish Atomic Energy Institution. Therefore, the relationship of residential radon gas and cancer couldn't be explained. But, in accordance with the inquiry result it was clarified that "there is a positive relation between the diagnosed chronic disease with the cigarette smoking people in the family and "the amount of daily cigarette consumption by smokers in family".

According to the World Health Organization (WHO), 3-14% of lung cancer cases are caused by low- and medium-level exposure to radon in homes. Radioactive radon is an inert gas that can migrate from soils and rocks and accumulate in enclosed areas, such as homes and underground mines. According to the EPA, the risk of lung cancer for smokers is significant due to synergistic effects of radon and smoking. For this population about 62 people in a total of 1,000 will die of lung cancer compared to 7 people in a total of 1,000 for people who have never smoked. It can, however, not be excluded that the risk of non-smokers should be primarily explained by a combination effect of radon and passive smoking. In order to protect family members from residential radon gas: The first step is to test your home for radon, and have it fixed if it is at or above EPA's Action Level of 4 picocuries per liter. There are also systems that remove radon from the crawl space or from beneath the concrete floor or basement slab that are effective at keeping radon from entering your home.

REFERENCES

[1] King PM, Kitchener K S. Developing Reflective Judgment: Understanding and Promoting Intellectual Growth and Critical Thinking in Adolescents and Adults. Jossey-Bass Higher and Adult Education Series and Jossey-Bass Social and Behavioral Science Series; 1994, San Francisco.

[2] Harris R, Introduction to Creative Thinking. http://www.virtualsalt.com/crebook1.htm; 2012.
[3] Hass, ML. Contemporary Issues in Lung Cancer: A Nursing Perspective. Jones and Bartlett Publishers; 2nd ed. 2010.
[4] Toxicological Profile for Radon. Agency for Toxic Substances and Disease Registry. U.S. Public Health Service in collaboration with U.S. Environmental Protection Agency. December 1990.
[5] A Citizen's Guide to Radon | Radon | US EPA. Epa.gov. 2010-08-05. Retrieved 2012-04-28.
[6] Health Risks. EPA. Retrieved 2008-06-26
[7] Tso T. C., Harley N., Alexander L. T. Source of Lead-210 and Polonium-210 in Tobacco. Science 19 August 1966; Vol. 153 no. 3738 pp. 880-882,
[8] Thad. G. Indoor Environment Quality. Boca Raton, FL. CRC Press LLC. 2001
[9] Toxicological profile for radon, Agency for Toxic Substances and Disease Registry, U.S. Public Health Service, In collaboration with U.S. Environmental Protection Agency, December 1990.
[10] President's Cancer Panel, Environmental Factors in Cancer: Radon, December 4, 2008.
[11] NRC, National Research Council Health effects of exposure to radon, BEIR VI. Committee on health risks of exposure to radon (BEIR VI), board on radiation effects research, commission on life sciences. Washington, DC : National Academy Press, 1988.
[12] U.S. Department of Health and Human Services, Guidance for Industry. Bioavailability and Bioequivalence Studies for Orally Administered Drug Products – General Considerations. Center for Drug Evaluation and Research, Food and Drug Administration, Rockville, MD. 2003.
[13] U.S. Department of Health and Human Services, 2004a. The Health Consequences of Smoking. A Report of the Surgeon General. U.S. Department of Health and Human Services, Center for Disease Control and Prevention, National center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, Atlanta, GA.
[14] U.S. Department of Health and Human Services, 2004b. Food and Drug Administration. Challenge and Opportunity on the Critical Path to New Medical Products. 9-20-2007.
[15] Peto, R, Darby S, Deo H, Silcocks P, Whitley E, Doll R.. Smoking, smoking cessation, and lung cancer in the UK since 1950: combination of national statistics with two case-control studies. BMJ 2000; 321, 323–329.
[16] Razzi, E. Reducing Radon's Toll. http://www.washingtonpost.com/wp-dyn/content.... 2009.
[17] S Darby, D Hill, A Auvinen, J M Barros-Dios, H Baysson, F Bochicchio. Radon in Homes and Risk of Lung Cancer: Collaborative Analysis of Individual Data from 13 European Case-control Studies. British Medical Journal, 2005, January 29, 330 (7485): 223.
[18] Replies to Radon in homes and risk of lung cancer: collaborative analysis of individual data from 13 European case-control studies. Bmj.com. Retrieved on 2012-04-14.
[19] Darby S, Hill D, Auvinen A, Barros-Dios, JM, Baysson H, Bochicchio F, Deo H, Falk R, Forastiere F. Radon in homes and risk of lung cancer: collaborative analysis of individual data from 13 European case-control studies. BMJ 330 (7485): 223-227. 2005
[20] WHO, Handbook on Indoor Radon, A Publıc Health Perspective, 2009.