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ORIGINAL ARTICLE

Evaluation of Radon Concentrations in some Samples of Dwellings of Lung Cancer Patients and Healthy Using CR-39 in Iraq

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ABSTRACT
Lung cancer is considered a disease that is completely happened by smoking; therefore, it is preventable perfectly. Yet, a small percentage of cases is there, possibly as many as 5 to 15%, in which there are other reasons. The risk factors acknowledged for the other groups comprise passive smoking, family history of cancer, occupational expo sure to certain chemicals and ionizing radiation, and diet. Moreover, a fifty samples from the dwelling of lung cancer patients were compared with twenty healthy volunteers. The study aims at identifying the dangers of radon gas in the dwelling of infected patients and the control group, clarifying how it contributes to increasing the risk of lung cancer. To achieve the aim of the study, the researcher used nuclear track detectors CR-39 , baguettes and TASLIMAGE System .
Keywords: Lung cancer, CR-39 Detector, Radon gas for dwellings, Iraq.

INTRODUCTION
Basically, humans are exposed to two types of radiation sources, and these sources are natural and artificial. The first source is a man-made while the other is a source that includes terrestrial internal radiation. In these two cases (i.e. sources), radionuclides help in emission of alpha or beta particles. Through inhalation or indigestion, these small particles can pass in the human body. The alpha particles are normally produced by the uranium decay process, thorium and their daughters. They have a harmful impact that can damage the cells of the human body [1]. Digging a little deeper, when the particles of alpha are directly inhaled, they get into the lungs; the lungs cells are affected, making some cases blood (leukemia) or lung cancer [2]. Radon is considered as a natural gas that has no odor and color and that it is a poisonous radioactive gas. Basically, radon contains three isotopes. These are 222Rn, 219Rn and 220Rn produced by decomposition of 238U, 235U and 232Th, correspondingly. Among these types, 222Rn is categorized as the greatest isotope that is effective. This is because 222Rn has a long half-life in comparison to other isotopes which is 3.82 days [3]. The residential radon is considered the first in never-smokers and a second risk factor in ever smokers for lung cancer, according to (USEPA) [4]. A recent methodical review on the lung cancer in never-smokers and the residential radon made a conclusion that there is a possible association though the involved studies mostly were not precisely dedicated on never-smokers [5]. Considering the influence of the residential radon that it has, there are many unresolved questions, not only on the risk that is initiated of developing lung cancer, but also on its features at the diagnosis time, as in the impact of indoor radon on the different histological types of lung cancer or on the tumor diagnosis age. There are no studies, to the best of our knowledge, that have measured if there is a relationship between the age and the exposure of residential radon at diagnosis. Concerning age, contradictory information exists at diagnosis in never-smokers. At an older age, some writers stated diagnosis in two French studies [6,7]; however, the other studies indicated that cancer of the lung might happen at a youth age in patients of never-smoking [8,9]. The cancer of lung cancer appears to be identified at an early stage in never smokers in comparison to ever smokers in Asiatic countries [10]. Nevertheless, in Europe and USA, the cancer of lung in never smokers is identified at a slightly older or at the same age than in ever-smokers [11].

It is the aim to take into consideration the following two questions in the current work: If there is a relationship between the risk of the lung cancer for diverse histological kinds and the concentration of residential radon and the second is when if the residential radon is related with the diagnosis of the lung cancer at early age. In doing so, we investigated a case-control study achieved entirely in smokers and never-smokers. Moreover, the radon has, as a gas, the ability to go away rapidly to the atmosphere from the ground and can simply decay making other short-life components identified as "radon daughters". When immediately the radon gas, as mentioned earlier, enters a human body through inhalation, possibly causing a lung cancer if it makes leukemia (blood cancer), if it moves to the blood, or it resides in the lungs [12]. Consequently, (IARC) categorizes radon as a carcinogenic agent [13]. Accordingly, knowing the concentration of the radon gas in our body is significant to assess its impact of radiation. Commencing on the previous fact, this work is intended to highlight the level of Rn222 in dwelling of the patients who suffer from the cancer of the lung and healthy people in Iraq by utilizing the method of solid state nuclear track, conducting whether the and the radon concentrations are within the allowable worldwide limits or not.

EXPERIMENTAL METHODS
The Middle Euphrates Oncology Center at the General Teaching Hospital in Najaf and Diwaniyah was the main source of distribution for the reagents under study. The reagents were distributed after taking the data from the patients of lung cancer and the control group from different regions of Iraq. Eighty reagents were distributed to patients and forty reagents to the control group, with a simple questionnaire that included age and gender with symbols, each symbol represents a specific person in the table (**1**) .

Table 1: The Two Groups Descriptive statistics

sex	Studies groups	No.
M	healthy people	13
	lung Cancer	25
F	healthy people	7
	lung Cancer	25

M: male, F: female, L.C: lung cancer.

For measuring radon concentrations, the CR-39 detector is 1 mm thick and 2.5 x 2.5 cm2(from track Analysys Systems Ltd, UK) in a plastic bag. As shown in Figure 1. Reagents are distributed in homes for a period of 4 weeks. After the period of this exposure, chemical etching was accomplished by Place the CR-39 reagent into a beaker encompassing the solution of a chemical agent. The chemical solution is organized by melting 50 gm of NaOH (6.25 N) in 200 ml of deionized water. When the detector gets dipping, the beaker is put under heat at 85°C for 3 hours in a water bath (type, HH-420, Germany). Through this step, the beaker is closed firmly so as to stop any changes in the concentrations of NaOH due to evaporation. Then, detectors were washed by utilizing distilled water. Track density as noticed by CR-39 detector (track/cm2) was calculated through TASLIMAGE system (Figure 2). Because the background has an impact on the density of the track, it was deducted from the recorded track density.

Fig 1: The two halves of hollow holder with CR-39 detector.


Fig 2: TASLIMAGE System.

Calculations: To specify the concentration of alpha particles (C^{α}_{Rn} , measured in Bq/m^3) in dwelling , equation (1) may be used [14].

$C^{\alpha}_{Rn}(\frac{Bq}{m^3})= \frac{\rho}{Kt}$……. (1)

Where ρ is the density of the track stated in Tr/cm2 , t is the revealing time sample, taken to be four weeks (exactly 30 days) and K is the diffusion constant. This constant is identified in some works as a sensitivity aspect or calibration factor [15].

$\rho(\frac{Track}{cm^2})= \frac{\text{Number of track}}{\text{Area of veiw}}$…….(2)

Where K value was calculated to be $0.21\,(\text{Track.}\,cm^{-2}/Bq.\,m^{-3}.\,day)$ [16].

RESULT AND DISCUSSION

Statistical analysis: Data are analyzed according to SPSS version 20 program, and samples are tested by the autonomous test. Thus, according to the associations among focus of collections a numerical importance remains demonstrated where the p- value is less than 0.05, but if larger than 0.05 it is not a significant value.

Biochemical Analysis Results: Dwelling Radon (Rn) level in patients and control groups: The comparison of dwelling Radon (Rn) level between lung cancer patients and healthy controls groups has been proved and the results were shown in table (4.1) and figure (4.1). Dwelling Radon Median levels in patients with the cancer of lung were higher than the median levels of control groups in comparison, 18.80 (35.08) versus 12.06 (26.63), the difference can be considered as non-significant (P =0.487).

Table 2: Median dwelling Radon (Rn) levels of lung cancer patients and healthy controls.

	Cases control comparison		
Rn	lung cancer patients n = 50	Healthy control n = 20	P
Range	0.16-137.32	0.16-97.30	0.487 † NS
Median (IQR)	18.80 (35.08)	12.06 (26.63)	

n: number of cases; SD: standard deviation; †: Mann Whitney U test; NS: not significant at P > 0.05 .

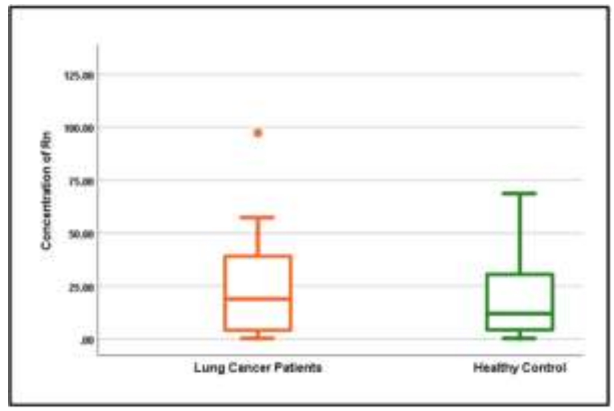

Figure 3: Box plot showing comparison of median dwelling Radon (Rn) level among patients with lung cancer and control subjects.

Evaluation of Radon (Rn): To evaluate the value of Rn cutoff and to predict the lung cancer as diagnostic tests or adjuvant diagnostic tests, the analysis of the receiver operator characteristic (ROC) curve was performed and the results are demonstrated in table (4.2), and figure (4.2). The value of Rn cutoff was > 10.63-fold with sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and area under curve of 52.0%, 60.0%, 75.50%, 33.3% and 0.487 (0.398- 0.709).

Table 3: Sensitivity and specificity of Rn level (> 10.63-fold) in lung cancer.

Rn level	lung cancer patients n = 50	Healthy control n = 20
> 10.63	26 (%)	8 (%)
< 10.63	24 (%)	12 (%)
Sensitivity %	52.0 %	
Specificity %	60.0 %	
PPV %	76.5%	
NPV %	33.3%	
AUC (95% CI)	0.487 (0.398- 0.709)	

CI: Confidence interval, AUC: Area under curve.

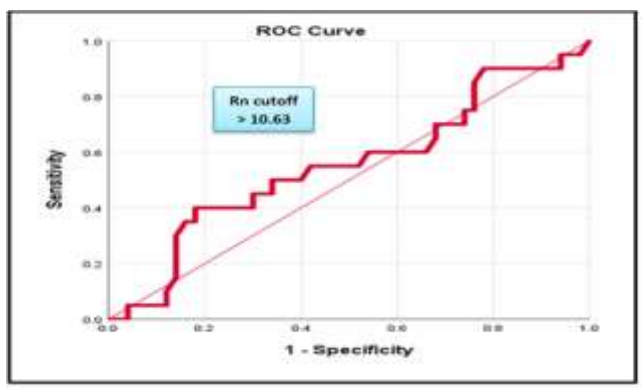

Figure 4: Receiver operator characteristic curve analysis of Rn for the calculation of possible diagnostic cutoff value.

Table 4: Comparison of Radon (Rn) levels of patients with lung cancer according to gender.

Characteristic	Gender		P
	Male	Female	
Cd (ppm)			
Mean ±SD	30.62 ± 27.91	14.21± 15.03	0.049 † S
Range	0.16 – 137.32	0.95 – 63.02	

SD: standard deviation; n: number of cases; †: Independent sample T test; S: significant at p > 0.05

Frequency distribution of Radon (Rn) levels according to gender: The frequency distribution of Radon (Rn) levels according to gender was shown in table (4.3). The mean Radon level of male was 30.62 ± 27.91 and it ranged from 0.16 – 137.32. The mean Radon level of female group was 14.21± 15.03 and it ranged from 0.95 – 63.02; the difference in mean of Radon level between male and female groups was significant (p = 0.049).

Frequency distribution of Radon (Rn) levels according to smoking habit: The frequency distribution of Radon (Rn) levels according to smoking habit was shown in table (4.4). The mean Radon level of smoking patients was 18.05 ± 17.05 and it ranged from 0.16 – 68.73. The mean Radon level of non-smoking patients was 27.14± 37.98 and it ranged from 0.63 – 137.32; the difference in mean of Radon level between smoking and non-smoking patients was non- significant (p = 0.285).

Table 5: Comparison of Radon (Rn) levels of patients with lung cancer according to smoking habit.

Characteristic	Smoking habit		P
	Smoking	Non-smoking	
Radon (Rn)			
Mean ±SD	18.05 ± 17.05	27.14± 37.98	0.285 † NS
Range	0.16 – 68.73	0.63 – 137.32	

SD: standard deviation; n: number of cases; †: Independent sample T test; NS: not significant at p > 0.05

CONCLUSION

In all the dwellings surveyed in the present work, the indoor potential alpha energy concentration was less than even the lower limit of the recommended value (53.33 mWL) given by (UNSCEAR, 1993) [17].

When comparing all the results of the present study in the air of the dwellings of lung cancer patients and healthy people in different cities of Iraq with local studies, it has been identified that the radon concentration (C) for the current study is lower than that found by (Louis) in Iraq [18].

The reason for radon values varying concentrations in the air of dwellings was due to several factors such as the nature of the soil and building materials used in homes in addition to the time period for the construction of the house, ventilating the house through a number of windows in each house, the behavior of the residents in the home, and the back disparity in these values, that dosimeters (closed) indoor distributed in houses enters only radon gas, without the other isotopes (thoron and actinon), because of the long half-life of radon and confined to his peers. Figure (1,2) shows the frequency of the radon concentration in the air of dwellings of the selected houses in Iraq.

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