Radon and Thoron Effects on the Human Health

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Content

Abstract

1. Introduction
   1.1 What is Radon & Thoron?
   1.2 The source of Radon & Thoron
   1.3 How does radon enter house?

2. Lung cancer

3. The measurement of radon & thoron

4. Radon Testing Methods

5. The health effect of radon

6. The risk of lung cancer from radon in home

7. The reduction of radon gas in the air

8. Radon Detection

9. Results and discussion

10. Conclusion

11. Reference
Abstract

Radon is a radioactive gas that emanates from rocks and soils and tends to concentrate in enclosed spaces like underground mines or houses. Soil gas infiltration is recognized as the most important source of residential radon. Other sources, including building materials and water extracted from wells, are of less importance in most circumstances. Radon is a major contributor to the ionizing radiation dose received by the general population.

Key elements for a successful national programme include collaboration with other health promotion programmes (e.g. indoor air quality, tobacco control) and training of building professionals and other stakeholders involved in the implementation of radon prevention and mitigation. Appropriate building codes that require the installation of radon prevention measures in homes under construction should be enacted, and the measurement of radon during the purchase and sale of homes is useful to identify those with high radon concentrations.

An overview is given for thoron levels in the environment and its contribution to the total exposure to indoor radon (radon-222) and thoron (radon-220). Because exposure to thoron is a health hazard, discusses the reasons for the increased attention to thoron issues, and the effective and practical control of indoor exposure to thoron. While reducing indoor radon and thoron as low as practically achievable, we should always remember the fact that choosing to not smoke is the most effective way to reduce the risk of developing lung cancer.

Radon isotopes are members of the actinium, radium, and thorium radioactive decay series. The most stable isotope has an atomic weight of 222 and a half-life of 3.8 days. Radon is widely dispersed in rock and soil, but because of its
chemical inertness, easily emerges from the ground and accumulates in enclosed spaces. Radon is a major source of human exposure to background radiation, and epidemiological studies have demonstrated that exposure to radon at high doses is a significant cause of lung cancer.

Since the half-life of thoron ($^{220}$Rn) is very short (55.6 s), its behavior is quite different from the isotope radon ($^{222}$Rn, half-life 3.8 days) in the environment. Analyses of radon and lung cancer risk have revealed a clearly positive relationship in epidemiological studies among miners and residents. However, there is no epidemiological evidence for thoron exposure causing lung cancer risk and it can be obtained.

Radon, thoron and their short-lived decay products in indoor places are recognized as the main sources of public exposure from the natural radioactivity. Radon ($^{222}$Rn) and thoron ($^{220}$Rn) are produced from soil and rocks due to presence of primordial radionuclide of $^{238}$U and $^{232}$Th in them. Radon migrates and appears predominantly by diffusion process in indoor environment. The decay products of radon can attach to surface of aerosols, dust and smoke particles which may be inhaled & become deeply trapped in the lungs. Thus, due to potential health hazards attributed to inhalation of radioactive contaminated air, it is necessary to assess the level of these radioactive pollutants.
1. Introduction

Radon ($^{222}\text{Rn}$) is a natural inert radioactive tasteless and odorless gas, whose density is 7.5 times higher than that of air [1]. It dissolves in water and can readily diffuse with gases and water vapor, thus building up significant concentrations [2]. The earth's crust contains trace amount of $^{238}\text{U}$ and $^{232}\text{Th}$ which decay to $^{222}\text{Rn}$ and $^{220}\text{Rn}$ thoron gas respectively [3].

Health effect of radon, most notably lung cancer, have been investigated for several decades. Initially, investigation focused on underground miners exposed to high concentrations of radon in their occupational environment. However, in the early 1980s, several surveys of radon concentration in homes and other buildings were carried out, and the results of these surveys, together with risk estimates based on the studies of mine workers, provided indirect evidence that radon may be an important cause of lung cancer in the general population [4]. Recently, efforts to directly investigate the association between indoor radon and lung cancer have provided convincing evidence of increased lung cancer risk causally associated with radon, even at levels commonly found in buildings. Risk assessment for radon both in mines and in residential setting have provided clear insights into the health risks due to radon. Radon is now recognized as the second most important cause of lung cancer after smoking in the general population [5].

The risk resulting from radon/thoron exposure depends, among other factors, on the activity of the radionuclide’s and from a theoretical perspective, a considerably small fraction of thoron atoms is required to produce the same activity as radon atoms [6].
Lung cancer’s very high associated mortality rate is even more tragic because a significant portion of lung cancer is preventable. While smoking remains the number one cause of lung cancer, radon presents a significant second risk factor. That is why, in addition to encouraging patients to stop smoking [7], it is important for physicians to inquire about and encourage patients to test for radon levels in their homes. Who have begun to include questions about the radon level in patients homes on standardized patient history forms [3].

1.1 What is Radon & Thoron?

Radon-222 is a radioactivity gas released during the natural decay of thorium and uranium, which are common, naturally accruing elements found in varying amounts in rock and soil. Odorless, invisible and without taste, radon cannot be detected with the human senses [10]. When radioactive elements such as radon decay, radiation is released. Products of radon decay like polonium-218 and polonium-214—emit alpha particles that are effective in damaging lung tissues [15]. Research has established a causal relationship with alpha-emitters and lung cancer in humans. Thoron is a naturally accruing radioactive gas. The principal source of thoron in indoor or air is building materials. Radiation doses are normally much lower than from radon. As shown in figure [1].
1.2 The source of Radon & Thoron

Radon is a natural radioactive gas without odor, color or taste. Radon can be detected by equipment. Radon occurs as a product of uranium decay. Uranium is a natural radioactive material found in varying amount in all rock, soils concrete and bricks it occurs everywhere especially in rocky and mountains area [1-2].

Radon is an unstable radionuclide that disintegrates through short lived decay products before eventually reaching the end product of stable lead. The short lived decay products of radon are Responsible or most of the hazard by inhalation [10].

Radon and its decay products called radon daughters or radon progeny emit highly ionizing alpha-radiation. Decay products are suspended in the air
which we breathe [9]. Although the risk is very low when radon is diluted to extremely low concentrations in the open, radon in room air typically contributes up to 55% as shown in Figure (2) below, to the background radiation. However, in places such as caves and mines, it can accumulate up to dangerous concentrations and may cause substantial [12-13].

Fig (2): The pie chart of Sources of the Radiation [12].
1.3 How does Radon & Thoron enter house?

Radon gas enters house from the grounded through cracks in concrete floors and walls through gaps between floors and slab and around drain and pipes and small pores of hollow block walls [11-14].

Consequently radon level are usually higher in basements cellars and ground floors depending number and factors the concentration of radon indoors varies with the time of the year from day to day and from hour to hour [16].

Because of this time variation reliably measurement of mean concentration in air should be made four at least three months. The level of radon in homes can be measured with simple device that are returned to the testing company to interpret the results.[16] Radon isotope thoron and its decay products gained less notice due to its relatively short half-life to reason however resulted in increasing attenuation of radiation protection to thoron lately: firstly, even smaller concentration of radioactive noble gases in the air are considered as noxious, secondly thoron common radon concentration in the order of magnitude of common radon concentration in the order of magnitude heavy metal thorium, which has always been present un the ground around the world.[11] It features as half life for only 56 seconds (that of radon is 3.8 day) can enter indoor air from the ground or the building martial within a few minutes there it decay via several different metallic decay produce in modern buildings, which exhibited a tight foundation, thoron cannot reach the indoor air from the grounded below the building due to it’s the short half- life.[14-15]

Most building martials are not known as thoron source either as the countian little thorium or area to tight for exhalation of thoron.[15]
2. Lung cancer

The lungs are part of the respiratory system. Cancers that begin in the lungs are divided into two major types as shown in figure 3, non-small cell lung cancer and small cell lung cancer, depending on how the cells look under a microscope. Each type of lung cancer grows and spreads in different ways and is treated differently. Within these types, lung cancer may be named for the type of cells in which the cancer develops.

![Fig (3) The comparison of a healthy and a diseased lung [4].](image-url)
3. The measurement of Radon & Thoron

Radioactivity of a radionuclide, for instance radon, is reported in Becquerel, Bq. 1 Becquerel (1 Bq) = disintegration of atom per second. Radon concentrations in the air are measured as the amount of radioactivity (Bq) in a cubic meter of air (Bq/m³).

It is possible for one house to have elevated levels of radon while a neighboring one does not. Measurement is the only reliable way to determine levels of radon in a house. Measurements are normally carried out using passive detectors which are left in the home for periods from days to months [14].

Because radon levels vary from day to day and from season to season, measurements over several months are better than short-term measurements for estimating annual average radon levels [18].

Detectors can be purchased from testing companies, but must be returned to them for assessment. To accurately reflect people’s true exposure to radon, detectors must be placed in rooms where people spend most of the time (living room, bedrooms, and offices). Instructions should be followed carefully when installing the detectors.

They should not be placed in rooms that are rarely used. There are three main types of passive radon detector [18]. The measurement of radon gas can be done through different detectors:
• Alpha-track detector (ATD): is normally placed for a period of one to 12 months.

Fig (4): Alpha-Detector

• Activated Charcoal Detector (ACD): is normally placed for period 2 to 7 day.

Fig (5): Charcoal Detector
• Electrical Integrating Device (EIC) are available with different sensitivities, some being suitable for measurements over a few and some being suitable for measurements over months.

Fig (6): Electret ion chambers detector

• Electronic Integrating Device (EID) are available with different sensitivities, some being suitable for measurements over a few days and some being suitable for measurements over months.

Fig (7): Electronic integrating device detector
4. Radon Testing Methods

The quickest way to test for radon is with a short-term "do-it-yourself" radon test kit, available by mail order and in many retail outlets or by hiring an EPA qualified or state-certified radon tester. Common short-term test devices are charcoal canisters, alpha track detectors, liquid scintillation detectors, electret ion chambers, and continuous monitors. A short-term testing device remains in the home for two (2) to ninety (90) days, depending on the type of device. Because radon levels tend to vary from day-to-day and season-to-season, a long-term test is more likely than a short-term test to measure the home's year-round average radon level. If results are needed quickly, however, a short-term test followed by a second short-term test may be used to determine the severity of the radon problem [17].

Long-term test devices, comparable in cost to devices for short-term testing, remain in the home for more than three (3) months. A long-term test is more likely to indicate the home's year-round average radon level than a short-term test. Alpha track detectors and electret ion detectors are the most common long-term test devices [18].

5. The health effect of radon

The adverse health effects of exposure to radon to radon are caused primarily by damage due to alpha-particles. The possible effect will depend on exposure level. The main danger from high radon exposure is an increased risk of lung cancer [12].
Radon as a noble gas is rapidly exhaled after being breathed in; however, radon progeny, combine with other molecules in the air and with particles of dust, aerosols or smoke, and readily deposit in the airways of the lung [13]. While lodged there, the progeny emit ionizing radiation in the form of alpha particles, which can damage the cells lining the airways. Experiments have confirmed that ionizing radiation affecting bronchial cells could cause cancer [14]. Epidemiological studies on thousands of uranium miners in different countries, including Germany, USA, Canada, Czechoslovakia, and others, also support this fact. Analysis have been undertaken of several miner studies, totaling 68,000 men of whom 2,700 died from lung cancer [17]. An increased risk of all histological types of lung cancer, including small cell carcinoma, and adenocarcinoma, cell carcinoma, has been associated with occupational exposure to radon [10-16].

But exposure to radon in houses can also lead to lung cancer, it is believed, for example, that every year more than 15,000 deaths from lung cancer occur due to radon exposure in the United States and more than 2,500 deaths in the United kingdom [13]. Lung cancer risk is much higher when radon exposure is combined with smoking. According to the BEIR IV report of the US National Academies of Sciences, for men exposed to radon at work, smokers were 10 times more likely to get lung cancer risk than non-smokers [18].

6. The risk of lung cancer from radon in home can be estimated by four ways:

1. By direct epidemiological studies of residential radon and by projecting occupational risk estimates to lower levels of radon in homes [15].
2. The uncertainties associated with residential studies are larger than those with miner studies, primarily because the risk is smaller at the low exposures encountered in most homes. It is also difficult to estimate the radon exposures that people have received over their lifetimes, probably in several houses [18].

3. Despite the uncertainties, it is clear that far more lung cancers are caused by smoking than are caused by radon. It is believed that the relationship between radon and risk of lung cancer is linear. In other words, doubling the exposure doubles the risk and halving the exposure halves the risk [18-19]. Doubling of the risk means much more for a smoker, who is already at high risk of lung cancer, than for a non-smoker with a very small baseline risk [15].

4. Lung cancer risk from residential radon exposure is substantially lower since the exposure in homes is much lower than in mines, although the risk increases with radon concentration level and duration of exposure [12-13]. For life-time exposure to radon of 20 Bq/m3 level at home the risk of lung cancer is estimated to be 0.3% (or 3 deaths in 1000 people). For comparison, risk of accidental death at home is 0.7% (or 7 in 1000). It has been suggested that other effects of radon exposure include increased risk of nonmalignant respiratory diseases but this is much less clearly established than the lung cancer risk [14].

It is still not clear whether children are more sensitive to radon exposure. Studies on childhood leukemia (the most common form of cancer in childhood) have not found clear evidence of risk associated with radon concentrations in homes [17-18].
7. The reduction of radon gas in the air

Radon levels in room air can be lowered in a number of ways, but only one of them is the most important. It is improving ventilation of the house letting in fresh air from outside and other examples can be sealing cracks in floors and walls to changing the flow of air into the building.

Some of these solutions are not suitable for all types of houses, nor are they suitable for all levels of radon. In some cases, more than one solution is needed in resolving the radon problem.

Radon safety needs to be considered when new houses are built. In many countries, for instance in England and in the United States, including protective measures in new buildings has become a routine procedure. These measures have been proven to keep radon levels well below the recommended action level, both in the short and long term. They also calculate the ventilation for the whole building [10].

**HEALTH EFFECTS OF RADON**

- Increases the probability of lung cancer
- x 10 times for smokers
- Stomach cancer
- Liver cancer
- Skin cancer
- Leukemia
8. Radon Detection

Measurements are performed with detectors which are left in the house for periods from days to months.

- Different measurement for every house
- Many detectors in different rooms

The levels are different for every country.

The reference level should not exceed 300 Bq/m³.

Radon in public drinking water supplies should not exceed to 100 Bq/l.

Public buildings & offices: 500 Bq/m³

Schools: 400 Bq/m³
Preventive measures that can be taken to reduce your exposure to indoor air pollutants include the following:

Environmental Tobacco Smoke (ETS)
- Don't smoke around others, particularly children.
- Every organization dealing with children should have a smoking policy that effectively protects children from ETS.
- In the work place, prohibit smoking indoors or provide separately ventilated smoking areas.
- If smoking is permitted in restaurants and bars, placement of smoking areas should be designated to minimize nonsmoker exposure.

Biological Air Pollutants
- Provide adequate outdoor air ventilation.
- Keep equipment water reservoirs clean.
- Eliminate standing water, wash bedding and soft toys frequently in hot water.
- Vacuum carpets and upholstered furniture regularly.

Volatile Organic Compounds (VOCs)
- Remove the source.
- Avoid use.
- Increase ventilation when using products.
Table (1): radon concentration in drinking water (Radon-222) and the contribution of to indoor radon concentration ($C_{aRn}^{222}$) for Erbil Governorate and its districts.

<table>
<thead>
<tr>
<th>Region No.</th>
<th>Region name</th>
<th>Water Radon Concentration (CwRn222) Bq/l</th>
<th>Contribution of radon concentration in drinking water to indoor radon concentration (CaRn222) Bq/l $\times 10^{-4}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Erbil city</td>
<td>5.11±0.044</td>
<td>18.242±0.157</td>
</tr>
<tr>
<td>2.</td>
<td>Kasnazan</td>
<td>5.61±0.08</td>
<td>20.027±0.285</td>
</tr>
<tr>
<td>3.</td>
<td>Ainkawa</td>
<td>6.12±0.2</td>
<td>21.848±0.714</td>
</tr>
<tr>
<td>4.</td>
<td>Qushtapa</td>
<td>7.33±0.11</td>
<td>26.168±0.392</td>
</tr>
<tr>
<td>5.</td>
<td>Shakholan</td>
<td>4.82±0.053</td>
<td>17.207±0.189</td>
</tr>
<tr>
<td>6.</td>
<td>Makhmur</td>
<td>8.42±0.2</td>
<td>30.059±0.714</td>
</tr>
<tr>
<td>7.</td>
<td>Koisnjaq</td>
<td>3.14±0.09</td>
<td>11.209±0.321</td>
</tr>
<tr>
<td>8.</td>
<td>Hujran</td>
<td>9.61±0.25</td>
<td>34.307±0.892</td>
</tr>
<tr>
<td>9.</td>
<td>Pirmam</td>
<td>4.63±0.09</td>
<td>16.529±0.321</td>
</tr>
<tr>
<td>10.</td>
<td>Shaqlawe</td>
<td>3.27±0.1</td>
<td>11.673±0.357</td>
</tr>
<tr>
<td>11.</td>
<td>Heeran</td>
<td>3.42±0.11</td>
<td>12.209±0.392</td>
</tr>
<tr>
<td>12.</td>
<td>Harir</td>
<td>8.83±0.13</td>
<td>13.523±0.464</td>
</tr>
<tr>
<td>13.</td>
<td>Khalifan</td>
<td>4±0.081</td>
<td>14.28±0.289</td>
</tr>
<tr>
<td>14.</td>
<td>Diyane</td>
<td>4.21±0.11</td>
<td>15.029±0.392</td>
</tr>
<tr>
<td>15.</td>
<td>Mergasur</td>
<td>3.56±0.13</td>
<td>12.709±0.464</td>
</tr>
<tr>
<td>16.</td>
<td>Sherwan-Mazn</td>
<td>3±0.084</td>
<td>10.71±0.299</td>
</tr>
<tr>
<td>17.</td>
<td>Barzan</td>
<td>2.62±0.077</td>
<td>9.353±0.274</td>
</tr>
<tr>
<td>18.</td>
<td>Barsreen</td>
<td>3.89±0.1</td>
<td>13.887±0.357</td>
</tr>
<tr>
<td>19.</td>
<td>Joman</td>
<td>2.51±0.074</td>
<td>8.96±0.264</td>
</tr>
<tr>
<td>20.</td>
<td>HajiOmaran</td>
<td>2.01±0.034</td>
<td>7.175±0.121</td>
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<tr>
<td>21.</td>
<td>Cidakan</td>
<td>2.46±0.066</td>
<td>8.782±0.235</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>4.693</td>
<td>16.756</td>
</tr>
<tr>
<td></td>
<td>ATDEV</td>
<td>±2.213</td>
<td>±7.9</td>
</tr>
</tbody>
</table>
Fig. (7): Results of radon concentration in drinking water in Erbil governorate and its districts
Table (2): Summary of the annual dose equivalent to the bronchial epithelium, stomach and the whole body from radon concentration in drinking water [3].

<table>
<thead>
<tr>
<th>Region Name</th>
<th>Annual dose equivalent to bronchial epithelium (mSv)</th>
<th>Annual dose equivalent to stomach (mSv) $\times 10^{-4}$</th>
<th>Annual dose equivalent to whole body (mSv) $\times 10^{-6}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erbil city</td>
<td>0.552±0.102</td>
<td>0.138±0.012</td>
<td>0.2761±0.04</td>
</tr>
<tr>
<td>Kasnazan</td>
<td>0.606±0.11</td>
<td>0.1515±0.018</td>
<td>0.3031±0.061</td>
</tr>
<tr>
<td>Ainkawa</td>
<td>0.6612±0.101</td>
<td>0.1653±0.018</td>
<td>0.3307±0.061</td>
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<td>Qushtapa</td>
<td>0.792±0.12</td>
<td>0.198±0.02</td>
<td>0.3961±0.081</td>
</tr>
<tr>
<td>Shakholan</td>
<td>0.5208±0.1</td>
<td>0.1302±0.011</td>
<td>0.2604±0.035</td>
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<td>Makhmur</td>
<td>0.910±0.14</td>
<td>0.2275±0.02</td>
<td>0.455±0.072</td>
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<td>Koinsnjaq</td>
<td>0.3392±0.09</td>
<td>0.0848±0.01</td>
<td>0.1696±0.021</td>
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<td>Hujran</td>
<td>1.0384±0.18</td>
<td>0.2596±0.03</td>
<td>0.5193±0.101</td>
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<td>Pirmam</td>
<td>0.5004±0.1</td>
<td>0.1251±0.02</td>
<td>0.2502±0.032</td>
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<td>Shaqlawe</td>
<td>0.3532±0.09</td>
<td>0.0883±0.01</td>
<td>0.1767±0.021</td>
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<td>Heeran</td>
<td>0.3696±0.08</td>
<td>0.0924±0.01</td>
<td>0.1848±0.021</td>
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<tr>
<td>Harir</td>
<td>0.954±0.11</td>
<td>0.2385±0.021</td>
<td>0.4771±0.076</td>
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<tr>
<td>Khalifan</td>
<td>0.432±0.101</td>
<td>0.108±0.012</td>
<td>0.2161±0.031</td>
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<tr>
<td>Diyane</td>
<td>0.4548±0.1</td>
<td>0.1137±0.01</td>
<td>0.2275±0.03</td>
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<td>Mergasur</td>
<td>0.3844±0.1</td>
<td>0.0961±0.012</td>
<td>0.1923±0.031</td>
</tr>
<tr>
<td>Sherwan-Mazn</td>
<td>0.324±0.08</td>
<td>0.081±0.01</td>
<td>0.1621±0.02</td>
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<td>Barzan</td>
<td>0.2828±0.09</td>
<td>0.0707±0.01</td>
<td>0.1415±0.02</td>
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<td>Barsreen</td>
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<td>0.2102±0.03</td>
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<td>0.0543±0.009</td>
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<td>Cidakan</td>
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<tr>
<td>Average</td>
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<td>0.1267</td>
<td>0.2536</td>
</tr>
<tr>
<td>ATDEV</td>
<td>±0.239</td>
<td>±0.0598</td>
<td>±0.1196</td>
</tr>
</tbody>
</table>
9. Results and Discussion

The recorded values of radon concentration (Bq/l) in drinking water are given in table (1). The average radon concentration in drinking water in Erbil governorate and its districts was 4.693±2.213 Bq/l. This value is smaller than the international recommended limit of 11Bq/l as proposed by the Environmental Potential Agency, USA [14].

Table (1) shows the evaluation results of the contribution of radon concentration in drinking water to indoor radon concentration. The increase of indoor concentration induced by drinking water in Erbil governorate is varying from $7.175 \times 10^{-4}$ Bq/l (0.7175 Bq/m3) to $34.307 \times 10^{-4}$ Bq/l (3.4 Bq/m3). The contribution to the indoor radon concentration is significantly higher in the houses where the drinking water is from artisan well water.

Carrying out linear relationship between radon concentration in drinking water and its contribution to indoor radon concentration are clearing in fig.4 and it was good agreement between theoretical value ($3.57 \times 10^{-4}$) and experimental results ($3.5699 \times 10^{-4}$).

The difference in radon concentration in different types of natural water is great. Generally, the radon concentration of spring and surface water is lower and drilled well water is higher. Therefore, the source of drinking water determines the effect level of radon in water to indoor radon concentration.

The analysis results of equilibrium factor between radon and its daughter, annual effective dose for radon concentrations in drinking water, The estimate results of average annual effective dose equivalents (Which are resulting from contribution of radon concentration in drinking water to indoor radon
concentration) were 11.546±8.566 μSv/Yr. In addition, this study was estimated by using ICRP Publication 65 methodology [15].

Tables (2) represent the summary of the annual dose equivalent to the bronchial epithelium, stomach and the whole body, which was induced from radon concentration in drinking water. In this table one observe that the annual dose equivalent to the bronchial epithelium which is due to lung cancer (0.5071±0.239) was higher than the levels for stomach (0.1267±0.059) ×10^-4 and the whole body (0.2535±0.119) ×10^-6, therefore levels found in this investigation are a good measure of the annual value. It is a good idea to repeat measurements at different times of the year to confirm this.
10. Conclusion

The radon concentration in this governorate was varying from region to another, and it has lower value 2.01 Bq/L in Haji-Omaran city (Spring well water) and higher value 9.61 Bq/L in Hugran region (Artesian well water) the reason is related to the type of source of drinking water and the geologic structure for that sources, so surface water is lower and groundwater is higher. Therefore the source of drinking water determines the effect level of radon in water to indoor radon concentration.

When these values are compared with the internationally recommended reference levels (U.S Environmental Protection Agency limit 11 Bq/l), we concluded that there are no indications of existence of radon problems in the water sources in this survey. From this research, it may be concluded that the radon concentration in drinking water will bring a definite additional radiological risk to the population. The average contribution of radon concentration in water to indoor radon concentration was \((16.756\pm7.903) \times 10^{-4} \text{ Bq/l}\). The estimate results of annual effective dose equivalents of drinking water in Erbil Governorate was \((11.546\pm8.566) \mu\text{Sv/Y}\) and this result was under estimating of ICRP Publication 65 methodology [15]. From table (2) one may be concluded that the drinking water contaminated by radon may increase the chances of developing stomach cancer and the breathing air high in radon concentration is more harmful to the health. Breathing in radon gas over a long period can increase the risk of lung cancer. In this research when we comparing our results within the seven countries ;Denmark, Finland, Germany, Greece, Ireland, Sweden and the Czech Republic, which have a set reference levels for radon in drinking water.
Reference


