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Hazard Assessment of Humanity as result of Biological Contamination with Uranium at Iraq Southern

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Abstract Depleted uranium (DU) is known to affect the health and well-being of humans. Exposure to DU weapons used by the United States troops and its allies has caused several types of exotic diseases, congenital malformations, and malignant tumors that have resulted in mild to severe abnormalities. This study aims to determine the amount of **DU** concentrations present in humans exposed to **DU** weapons. The Basrah District was chosen as the study site because this district was involved in the Gulf War in 1991 to 2003. Data were collected from hospitals, universities, and health institutes from 1989 to 2010. Blood, tissues, bones, urine, and teeth infected by cancer where compiledas data samples. The **DU** ratios of each person in the diverse sites of the Basrah Governorate were obtained for analysis. Descriptive statistics was obtained for the dataset. Results of this study shows that the mean of the **DU** ratio in the infected samples was 0.018 ppm in 1994 and was 1.27 ppm in 2010. Results also indicating that the **DU** ratio exceeded the standards level significantly. The **DU** concentration rates increase with increasing the years, due to the accumulation of $\mathbf{U^{238}}$ series radioisotopes in the human organs. The lung has the highest **DU** ratio, followed by the kidney, bones, urinary bladder, and teeth, successively. Analysis findings indicate the presence of radiological pollution significantly in some areas, and lead to uranium enters the human body through respiration or through ingestion of contaminated food and drink. Airborne uranium also contains particles that accumulate in the human organs.

Keywords Depleted Uranium, Environmental Pollution, Organs Human, Health Hazards

1. Introduction

Depleted uranium has radioactivity less than that of uranium raw, primarily disintegrates through the emission of alpha particles. Although it cannot penetrate the external skin layers, DU may affect the internal body cells when ingested or inhaled. Inhalation or ingestion of large amounts of dust and particles have caused carcinogenic diseases, miscarriages, congenital birth defects, leukemia, lung diseases, bone diseases, skin diseases, and other chronic and fatal illnesses in Iraqi communities. Several studies conducted in different universities and health institutes and radiological departments, confirmed the increase in the incidence of tumors and strange diseases in Basrah after 1994. The incidence of tumors continuously increases with time because of the resuspension of DU particles and the ingestion of DU by children via contaminated food, water, and soil. The radionuclide can enter the human body through the following pathways: external exposure, direct contact with radioactive material, and internal exposure that can occur through inhalation, ingestion, and skin contact. These pathways are site-specific and depend on the occupancy of the site[1].

Some studies were unsuccessful in finding a single comprehensible DU-positive sample, and the extent to which these tested materials are exposed to DU was not known. Therefore, if urinary DU cannot be identified by using sensitive methods over a period of 10 years to 20 years, then the exposure of the tested group to DU cannot be verified[1]. This result is similar to that of the Kuwait and Southern Iraq case, in which urinary DU was documented in exposed individuals for over 25 years. An individual exposed to DU will exhibit urine isotope signature for decades. Although the effects of DU exposure to human health cannot be justified because of the limited evidence of DU exposure, many diseases that could be attributed to DU exposure have appeared recently[2, 3].

Radon exposure is responsible for about 21,000 lung cancer deaths per year in Ohio, United States. As many as eight million homes in this area have increased radon gas levels. Several programs employing a number of mitigation methods were started during the late 1980s to reduce the number of deaths attributable to radon-related lung cancer[4,5]. Thus, rapid measures were conducted to limit the high radon levels 2 pCi/l[6]. Several factors can increase and spread radioactive pollutants, such as cutting operations and transfer of devastating DU-contaminated armors from

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one area to another in Southern Iraq[7]. The movement of pollutants into aquifers is governed primarily by convection and dispersion[8]. These processes, which are controlled mainly by hydraulic distribution into aquifer, generally exhibit geological properties; these processes may also increase pollutant dissemination that can lead to carcinogenic diseases after a long time[9, 10].

[11]Suggested that to appraisal the presence of bullets, missile, U^{236}, and artificial radionuclides in soil indicates that contaminated particles come from dismantled materials through weathering. Environmental samples, which include air, soil, lichens, food, and drinking water, as well as bio-monitoring samples, such as urine, blood, and tissue samples from soldiers and citizens, denote higher contamination compared with natural background levels among the local population. No special human or environment monitoring such as that conducted in the Gulf or Kosovo region was applied to analyze DU munitions debris. According to[12], DU may enter the human body in the form of uranium fragments or as oxides from the DU oxidization process. Despite the high amounts of DU dispersed to the ground, high concentrations of DU were found in suspended sediments carried by runoff water to the bottom through porous structures. However, studies on test sites in the United States did not reveal any local groundwater contamination[13].

Several techniques have been used to determine uranium concentrations in biological samples. For instance, solid-state nuclear track detectors have been utilized to obtain the uranium concentration in human blood or other samples, as applied by[14, 15]. In addition, fission track nuclear technique by thermal neutron irradiation of solid-state track-recording materials has been recommended for the quantitatively determination of uranium in blood, using a CR-39 nuclear track detector.[16] Determined the uranium concentrations in the blood of some inhabitants in Iraq who have worked in the radiation field. The highest recorded uranium concentration was found in the blood of workers in the radiological fields and those living in the Basrah Governorate. By contrast, the lowest uranium concentration was found in those living in Baghdad. The uranium concentrations of female workers were shown to be higher than those of male workers.

[17]Collected data and subjected these data to statistical analysis and descriptive statistics to assess the amount of **DU** inthe biological samples of Basrah inhabitants. No correlation was observed between the increase in cancer cases in the contaminated areas and the exposure level to **DU** weapons. This result alsoagrees with the findings of the recent studies on uranium exposure and cancer. The current studyaims to define the amount of **DU** concentrations in each organ of the Basrah inhabitants, identify the organs that are more affected by the **DU** exposure, and assess the environmental hazards.

2. Study Area

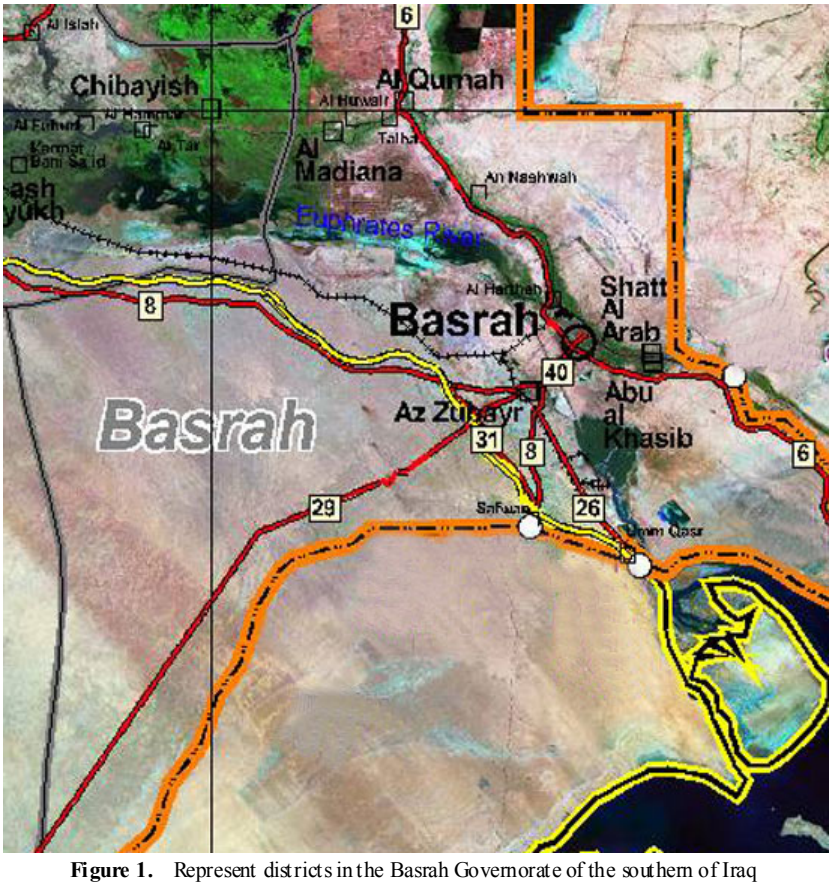

Figure 1. Represent districts in the Basrah Governorate of the southern of Iraq

Basrah Governorate is divided into seven districts according to the topographical system used by the Basra Municipality. These districts include the Basrah center, Zubayr, Al-Qurna, Al-Mudaina, Abu-Alkhaseb, Shatt Al-Arab, and Al-Fao. Basrah, which has a total population of approximately 2.7 million, is considered the primary harbor of Iraq, as shown in Figure 1. Basrah is experiencing a range of ecological problems that are both instantaneous and acute over the past 30 years. Some of these ecological problems can be directly linked to the effects of the recent military conflicts. Basrah was damaged during the Iran–Iraq War in 1980, and then many of projectiles and missiles were dropped over Basrah province during 1991 until 2003. All these wars carried out at last intervals make this region susceptible of contaminate, due to toxic heavy metals and radionuclides containing **DU** projectiles are present in some sites of Basrah until now. Several cases of cancer have been observed widely in these areas recently, due to **DU** weapons.

3. Methodology

Employees who are working in radiation departments, hospitals, and healthy sectors underwent cancer screening. Several processes were performed to specify the diseases prominent in the population. Attempts to treat these diseases were then conducted. Precautions were also given to people living in polluted areas.

Data were taken randomly from citizens and army individuals living in contaminated areas for the last 20 years and who have participated in the wars at Basrah. Number of infected persons was chosen based on percentage of the population for each site of study area. Data were collectedfrom different locally registered universities, health institutes, and radiological departments to obtain statistics representing the name, age, sex, address, number of deaths, cancer cases, and infected human organs. The obtained data were modeled statistically by using the software program IBM **SPSS**Statistics 20.**SPSS** (Statistical Package for the Social Sciences) is a computer implementation, which offers statistical analysis of datum. It permits for detailed data admittance and provision, analytical reportage, charts and modeling. The invention name where altered after 2009 from **SPSS** to Predictive Analytics Software (**PASW**).

Descriptive statistics was carried out for each variable to visualize the influencing factors, which include the Mean, Median, Maximum, and Minimum values, as well as the Standard Deviation, Skewness, and Variance of the confidence level (95%). To analyze and assess the possible hazards of DU exposure on human organs, readings were obtained by using several procedures and instruments, such as autocorrelation, Pearson correlation, Spearman coefficients, and Analysis of variance (ANOVA) that is tool and conducting statistical derivation, which permits we have to deal through some factors. **SPSS** was also used to specify significantly correlated variables and to determine whether location is correlated with the time. ANOVA was used to describe the effects of each factor, effect of all the factors, and the relation among groups. Standard deviation was used to define the distance range amid readings, and statistical means were used to distinguish the highest or lowest values of the readings. The Pearson correlation of the DU ratio and the type of human organs affected within different areas and years was calculated. All variables were described and were given higher or lower values. Secondary datasets were chosen on the basis of statistically significant correlations ($p< 0.05$) and on the visual inspection of linearity on a scatter plot.

4. Result and Discussion

Figure 2 represents the distribution of DU ratio and occurrence rates of cancer cases in each district of the Basrah Governorate. The highest DU ratios were found in the Zubayr District with 0.704 ppm, followed by Basrah City with 0.651 ppm. The lowest DU ratio was found in the Al Fao District with 0.417 ppm. Thus, we can divide the study area into three categories according to contamination and DU ratio in the human organs during both wars (1991–2003). The highest DU ratios were identified in the Zubayr and Basrah Districts. Moderate values were found in Al Qurna, Abu-Alkhaseb, and Al-Mudiana Districts. Low values were found in Shatt al Arab and Al-Fao. The area with the highest DU ratio in the Zubayr District has high values of infected organs in the human beings because this area has been exposed to different wars. In particular, many artilleries, tanks, missiles, projectiles, and armor vehicles have been abandoned in this area, where stimulated on the spread contaminants within environment, then causing diverse types of carcinogenic diseases. The AlFao and Shatt Arab Districts have low cancer occurrence because these areas are located far from the conflict fields. Figure 2 also shows that DU averages within human body has increased for each year, where ranged 0.018 and 1.27 ppm in 1994 and 2010, respectively, due to uranium particles has the ability to accumulate in human organs, especially in the bone tissues, with time. We noticed that theDU ratio exhibited an increasing trend from 1994 until 2004 ascending, and then reached its peak and stability in the last years. Some of these results were confirmed to be largely correlated with contaminated areas and with the occurrence of carcinogenic diseases.

Table 1. Descriptive statistics for the entire variables such as DU ratio, age, and years

	Min	Max	Mean	S.D.	Vari.	Stati.	SE
Year	1994	2010	2002	4.995	24.95	-.095	.118
DU	.0013	2.36	.613	.6336	.401	.945	.118
Age	12	69	41.96	15.51	240.6	.003	.118

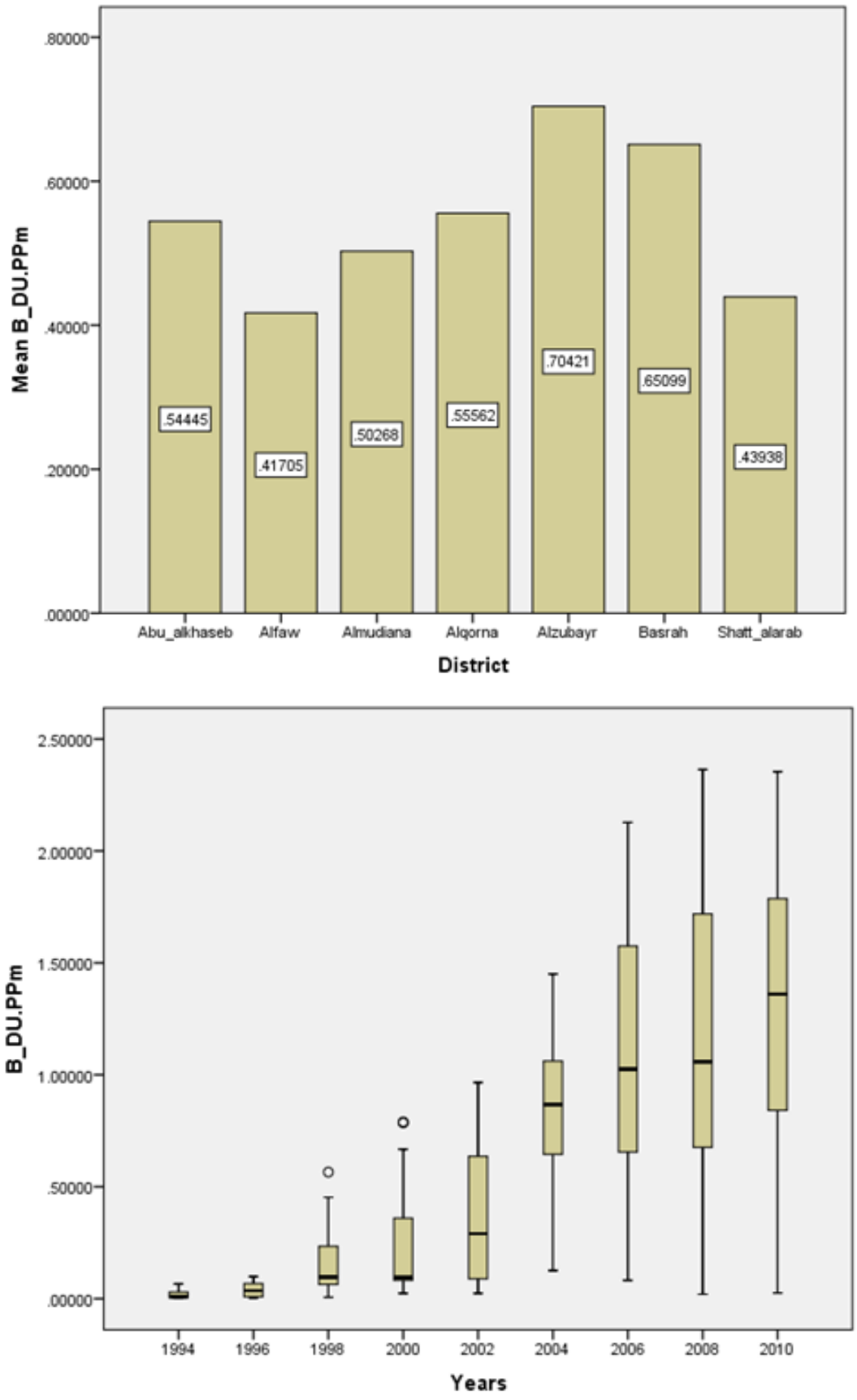

Figure 2. Averages of DU ratio into human organs for both diagrams on the (A) at each district, (B) with each year at Basrah Governorate

To describe and assess all the values obtained, descriptive statistics analyses were conducted on some of the variables, including DU ratio, age, and years. Twenty years ago, the mean of the DU ratio in the human body was 0.613 ppm, which indicated that the DU concentrations exceeded the criteria levels. The standard deviation and variance showed that convergence intervals exist among the increasing values of DU ratio. This result confirms the high percentage of cancer occurrence in recent years. The mean age for each cancer case among the Basrah people is 42. Dust and DU particles accumulated in the organs of the Basrah inhabitants after a long time. These particulates were deposited in the skeletons and other organs progressively and were then emitted back to the blood flow of the inhabitants. Many types of organs such as the lungs, bones, bladder, and breast can deposit contaminant elements.

The above organs are also included in the ten most common cancers in the world. The lung has the highest DU ratio that is 0.972 ppm, followed by the kidney with 0.888 ppm and the bones with 0.8 ppm. The teeth with 0.09 ppm have the lowest DU ratio, as shown in Figure 3. This result led to some health complications ranging from carcinogenic diseases to kidney fiasco, breathing difficulties, congenital abnormality, skin infections, and other strange diseases. This study demonstrated that the DU ratio in males is 0.64 ppm, which is higher than that in females (0.59 ppm). The higher DU ratio in males can be attributed to the fact that males accomplish works that require them to be in direct contact with contaminated substances. Results also show that the DU concentrations are 1000 times higher compared with the allowed natural uranium in the human body (i.e., 0.0004 ppm for the bones and 0.001 ppm for the rest of the human organs[18].

The above findings also appeared in many variable relations. Tables 2 and 3 show that the relationship among Pearson correlation coefficients, Spearman's correlation coefficients, and significant p-values is statistically significant. These analyses demonstrate that the correlation coefficients have significant differences. The DU ratio and years have difference equal to 0.811, thus denoting a strong correlation between the two variables. Statistical analysis was performed on the variable age with DU ratio and years at the significance level ($p < 0.05$). No significant differences were observed among them. In addition, a weak correlation was observed among these variables because the p-value is higher than 0.05. An increase in age is accompanied by increases in DU concentrations. This result indicates that the mean Pearson correlation relative to age is not significant at the 0.05 level, and a feeble correlation exists among the variables. Figure 4 shows that an increase in years is accompanied by an increase in DU concentrations in the human organs. Therefore, the increase in DU ratio with time indicates that uranium concentrations are accumulated in the human organs with time. The scatter plot charts of the correlation coefficients between DU ratios and years also exhibited a linearly significant correlation ($R^2 = 0.540$). Also there are significant differences between groups both of the DU ratio and age due to the distances among averages values to DU ratio of 72.9, which are more far than between age values. Then appear the correlation between groups is significant with the DU ratio, and no significant with the age due to the distances among averages are convergent, Table 4. So, the uranium content of the infected samples exceeded the limit specified above. This increase in uranium content can be caused by the Iraq wars in 1991 to 2003. Therefore, DU weapons should be prohibited because of their destructive effects on civilians and their damaging effect on the environment for thousands of years to come. That's agreeing with[19, 20,and 21].

Table 2. Pearson correlation coefficients showed the variables and significant p-values, which have statistically significant analysis

Pearson Correlations[b]		DU	Age/Y	Years
DU/PPm	Pearson Correlation	1	.046	.735**
	Sig. (2-tailed)		.342	.000
Age/Y	Pearson Correlation	.342	1	.028
	Sig. (2-tailed)			.564
Years	Pearson Correlation	.735**	.028	1
	Sig. (2-tailed)	.000	.564	

**Correlation is significant at the 0.01 level (2-tailed).

Table 3. Spearman's-rhocorrelation coefficients of the variables that have statistically significant analysis

Spearman's rho Correlations[b]		DU	Ag	Years
DU/ PPm	Correlation Coefficient	1.000	.032	.811**
	Sig. (2-tailed)	.	.512	.000
Age/ Y	Correlation Coefficient	.032	1.000	.026
	Sig. (2-tailed)	.512	.	.589
Years	Correlation Coefficient	.811**	.026	1.000
	Sig. (2-tailed)	.000	.589	.

**Correlation is significant at the 0.01 level (2-tailed).

Table 4. Analyses of Variance for DU ratio (PPm) and age per year

ANOVA		Sum Squares	df	Mean Square	F	P-v Sig.
DU/ PPm	BG	99.581	8	12.448	72.9	.000
	WG	71.421	418	.171		
	Total	171.003	426			
Age/ Y	BG	413.673	8	51.709	.212	.989
	WG	102082.650	418	244.217		
	Total	102496.323	426			

BG= Between Groups
WG= Within Groups

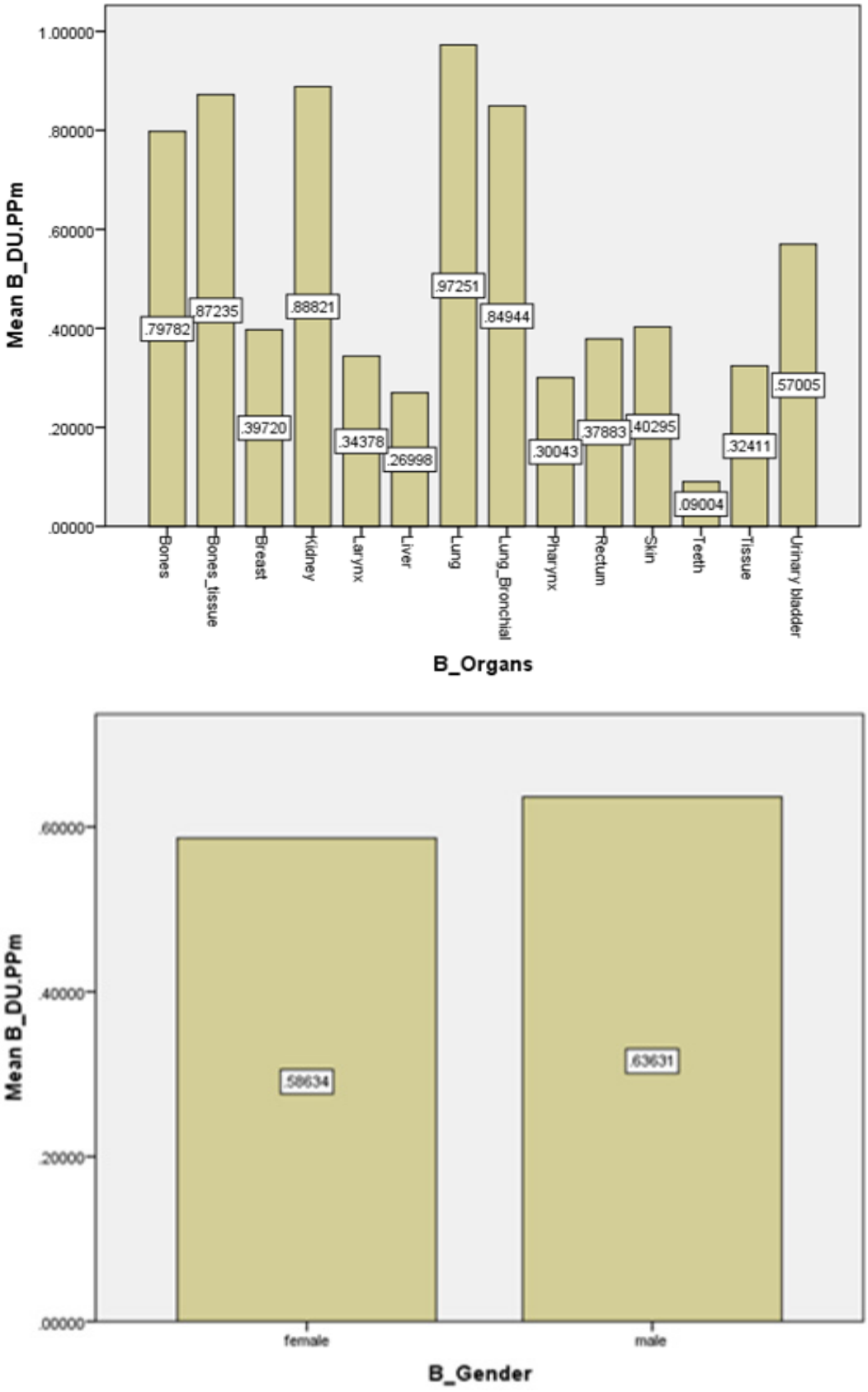

Figure 3. Average of DU ratio in the human organs for both diagrams on the (A) at the Organ type, (B) with the Gender type at Basrah governorate

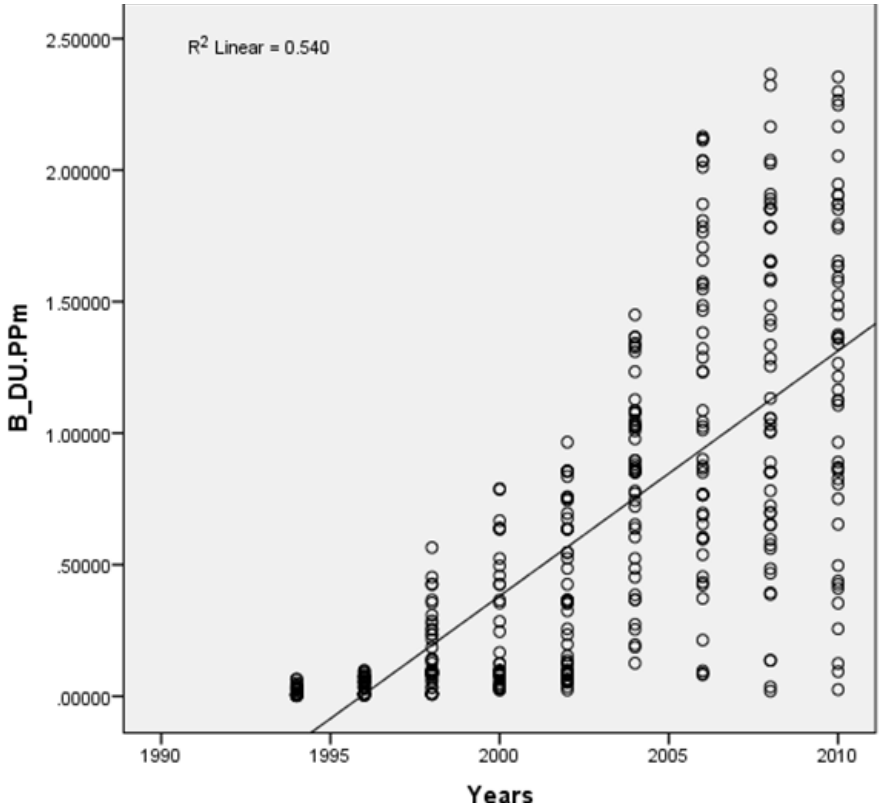

Figure 4. Scatter plotexplained moderate correlation between DU concentrations with the yearsin the human organs

5. Conclusions

❖ This research is to determine the amount of DU concentrations in human beings, which have been exposed to DU weapons. DU concentrations were appeared in the lung is higher comparison with other organs followed by kidney, bones, urinary bladder, and the teeth is lowest value of DU ratio.

❖ According to the gender type, where appeared the DU concentrations into male are higher than of females.

❖ Data analysis proved an increase in the DU ratio in the human organs among Basrah population. So, Zubayr district has average higher than other districts and Al Fao has low value of DU ratio in the human organs.

❖ The low value of DU ratio in the human organs at 1994, while inference on the higher values of DU ratio is 2010 until now. We have stability in increasing these cases after 2006 due to uranium particles has been accumulated within these organs with the time.

❖ There are increases the DU concentrations with the years. Perhaps the large part attributed to exposure to DU, In addition to the gases emitted of factories or generating stations, causing carcinogenic diseases to people who are living at contaminated areas.

❖ New method of statistical analyses that used to describe variables statistically, and determine DU concentrations, for different areas and years at once. It is highly recommended to evaluate of DU concentrations in this procedure and understand whether the correlation between DU and occurrence of cancer diseases to assess human health seriously. Therefore, we noticed many of carcinogenic cases have been increased after 2006 at Iraqi southern.

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