Open Access
Published Online First: January, 2023

Baghdad Science Journal
2023, 20(4): 1425-1432

P-ISSN: 2078-8665
E-ISSN: 2411-7986

DOI: https://dx.doi.org/10.21123/bsj.2023.6889

A Statistical Study of the Amount of Radiation Generated from Communication Towers in the Nineveh Plain Region, Baghdeda

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Received 1/1/2022, Revised 17/7/2022, Accepted 19/7/2022, Published Online First 20/1/2023, Published 1/8/2023

Abstract:

This research presents a statistical study of radiation generated from communication towers in the Nineveh Plain region Baghdeda. The intensity of radiation energy was measured at 10 meters away from the communication tower in different locations, using a (1PC XH-901 Dosimeter/ Personal Dose Alarm / Radiation Detector, dosage rate: 0.01 µSv/h to 150µSv/h) to measure the amount of radiation at various times. Energy densities were measured and compared with standard limits provided by other authorities, such as the International Committee for Radiation Protection. Results were analyzed using SPSS version 26 to implement the data. The results show that the means of the radiation levels measured at all the zones do not statistically differ from the highest values determined globally 0.50-1.70 µSv/y; they lie within the radiation-free zones. Civilians may not always have a choice where the mobile tower will place. As a result, it may rely on some quick fixes, such as certified radiation protection items that offer all-around protection from mobile tower irradiance. The radiation shielding technology used in these goods alters the nature of irradiation from a constant to a variable waveform, rendering it useless.

Keywords: Communication towers, Nineveh Plain region, P-value, Radiation, Statistical SPSS.

Introduction:

In recent decades, the widespread use of cell phones has led to an enormous increase in cell phone towers placed in communities. These towers have electronic equipment and antennas that transmit cell phone signals using radiofrequency waves [1-4]. The radiation emitted via mobile phones and mobile sites causes many health problems (cancers, reproductive problems, neurological, and hormonal disorders). As mobile phones grew, so did the demand for mobile towers built to serve many mobile users. Mobile phones have become an essential part of our lives because of the necessity for communication. One needs a smart telephone in our homes and business for various reasons. People are constantly exposed to radiation because of our proximity to this multifunction wireless technology. As a result, there's more tension and exhaustion, irritability, poor quality sleep, headaches, and a slew of other difficulties [5-7]. There are two types of radiation; ionizing irradiation, which includes X-rays, and non-ionizing radiation includes mobile phone rays, computer radiation, desktop radiation, iPad radiation, TV radiation, and rays from Wi-Fi routers and networks boosters. Considering the dangerous radiation emitted by mobile towers near our houses [8-10]. Mobile rays and mobile tower irradiation cause cancer in specialists, academics, and other clinicians. They're all aware of the negative side effects of radiation released by Wi-Fi devices, such as cell phones, mobile phone towers, or other mobile electronic devices. According to the World Health Organization (WHO) [11], such rays can cause damage to the human brain and lead to cancer when exposed to them for long durations, putting them in the same classification as fumes and pollution. Besides the WHO's substantial proof of a link between electromagnetic waves and cancers, a few occurrences have established the link between mobile tower irradiation and major human health difficulties [12]. Where the radiation levels measured globally are from 0.50-1.70 μSv/y [13]. Major papers conducted by the U.S National Toxicology Programed (NTP) [14] and the Ramazzini Institute in Italy subjected a group of laboratory rats to RF waves several times a day [15], beginning before conception and continuing for the majority or even all their natural lifetimes, they found groups of rats had a higher hazard of malignant schwannomas, which are rare cardiac tumors, in both investigations, whereas female mice were not. The study also found a connection between specific brains and adrenal cancers and an elevated death rate [16-18].

The goal of this study is to calculate and a statistical study of the amount of radiation generated from communications towers in the Nineveh Plain region Baghdeda and the extent of its impact on the health of people and the environment.

Materials and Methods:

In this work, the twelve zones in six alleys were selected in Baghdeda from the Nineveh Plain in Iraq. Maps of areas of recorded radiation levels at all times of the day using ArcMap 10.3 are shown in Fig. 1.

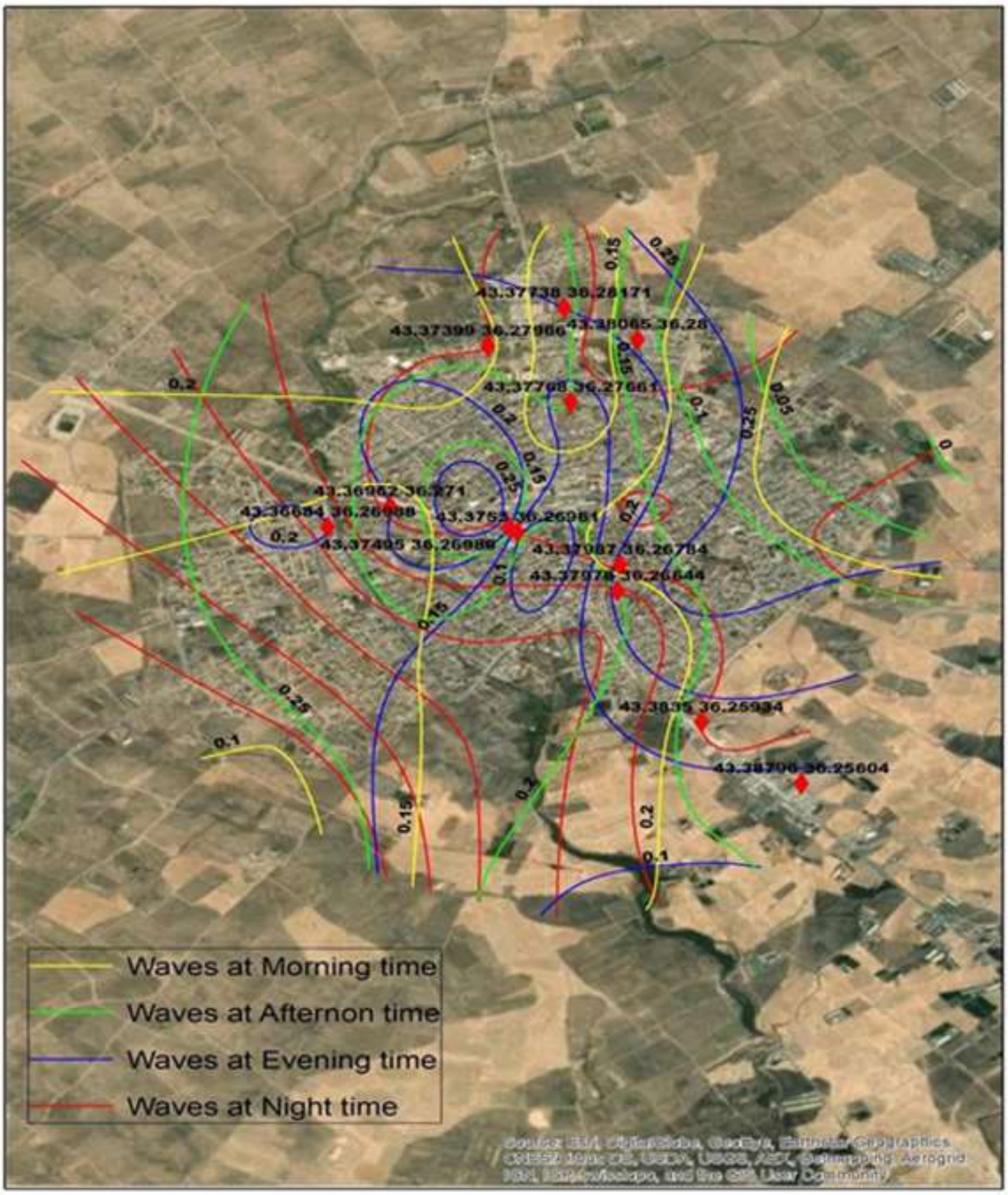

Figure 1. Maps of areas of recorded radiation levels at all times of the day using ArcMap 10.3.

The amount of radiation was measured and compared with standard limits provided by other authorities, such as the International Commission for Radiation Protection[11]. The amount of radiation emitted from the towers of these sites was measured using a radiometer (1PC XH-901 Dosimeter/ Personal Dose Alarm/ Radiation Detector, Dose rate: 0.01 μSv/ h to 150μSv/ h), during different periods of the day (in the morning, at noon, afternoon, in the evening), and a 10 meter away from the tower site Table 1 and 2. The Statistical software SPSS version 26 was used to implement the statistical analysis of the data shown in Table 1.

Table 1. Radiation level microsievert per hour emitted from the towers in the investigation area measured at four different times at a 10 m distance from the towers

Alleys	Zone	In the morning,	At noon	In the afternoon	In the evening
Somer	1	0.21	0.18	0.21	0.21
	2	0.18	0.20	0.21	0.14
	3	0.18	0.14	0.20	0.20
	4	0.18	0.18	0.12	0.20
Ashur	5	0.14	0.18	0.20	0.21
	6	0.14	0.21	0.20	0.12
Sinharib	7	0.21	0.21	0.18	0.20
	8	0.12	0.21	0.20	0.21
Kalih	9	0.18.	0.12	0.21	0.18
	10	0.21	0.14	0.18	0.20
Rasin	11	0.21	0.14	0.14	0.18
Akad	12	0.12	0.20	0.14	0.21

The measurements values have transformed from (μSv) per hour to (μSv) per year. The new measures have been gated as illustrated in Table 2 by using the following relation $Y = X \times 24 \times 365$, where X: stands for the radiation level per hour and Y: stands for the radiation level per year in table 2.

Table 2. The measured radiation level (μSv/y) emitted from the towers in the areas of investigation at four different times and 10 m distance from the towers

Alleys	Zone	In the morning,	At noon	In the afternoon,	In the evening,
Somer	1	1.8396	1.5768	1.8396	1.8396
	2	1.5768	1.7520	1.8396	1.2264
	3	1.5768	1.2264	1.7520	1.7520
	4	1.5768	1.5768	1.0512	1.7520
Ashur	5	1.2264	1.5768	1.7520	1.8396
	6	1.2264	1.8396	1.752	1.0512
Sinharib	7	1.8396	1.8396	1.5768	1.7520
	8	1.0512	1.8396	1.7520	1.8396
Kalih	9	1.5768	1.0512	1.8396	1.5768
	10	1.8396	1.2264	1.5768	1.7520
Rasin	11	1.8396	1.2264	1.2264	1.5768
Akad	12	1.0512	1.7520	1.2264	1.8396

Results and Discussion:

Hypothesis 1: there are no statistically significant differences between the rates of radiation levels recorded at different times of the day at a distance of 10 m from the towers for all the investigated zones. Results show that; the radiation levels mean rates values in different zones recorded at a distance of 10 m in different day times (in the morning=1.5184, at noon=1.5403, in the afternoon=1.5987, and the evening=1.6498) are close to each other. The minimum value was 1.0512 μSv/y, and the maximum value was 1.8396 μSv/y. The standard deviations of recorded radiation mean rate for all the zones in the morning amounted 0.3065 μSv/y, at noon 0.2856 μSv/y, in the afternoon 0.2773 μSv/y, and in the evening 0. 25834 μSv/y. The above results show that the radiation levels increase over time until they reach the climax in the evening, whereas the standard deviation values decrease. The results offer the closeness of the radiation rates to each other in the evening. Statistically, the F-test was used through the one-way analysis of variance (ANOVA) to verify the absence of significant statistical differences among the radiation rates. All values of radiation levels from the towers for all the investigated zones are below of permissible values of radium, as recommended by the International Committee for Radiation Protection[19].The results are in Table 3.

Table 3. ANOVA table for emitted radiation rates (μSv/y) from the towers in the investigated zones at four different times of the day at 10 m distance from the towers

Variance sources	degree of Freedom	Sum of Squares	Mean of Squares	F-value	p-value
Between times	3	0.127	0.042	0.529	0.665
Within times (error),	44	3.511	0.080		
Total	47	3.637			

The ANOVA results show that the p-value (statistically significant) of the F-test (statistical test) is 0.665, which is greater than the significant level of 0.05 (a statistically significant test result ($P \leq 0.05$) means that the test hypothesis is false or should be rejected [20-23]); this indicates no significant differences among the means of the radiation rates recorded at the different times of the day at 10 m distance from the towers for all the investigated zones. Statistically, to verify that no significant statistical differences between each radiation recorded means the Least Significant Difference (LSD) test, which is one of the post hoc analysis of variance tests used. The results show that the p-value for all differences in the mean radiation levels at two times during the day was greater than the level of 0.05. The result indicates no statistical significance between the means of radiation levels recorded for all the investigated zones. Based on the aforementioned, the first study hypothesis states" that there are no statistically significant differences between the means of the recorded radiation levels at different times of the day at 10 m distance from the towers for all the investigated buildings" has been verified.

Hypothesis 2: radiation rates recorded at different day times are within the global fixed limits of safe non-ionizing areas free of radiation. When the means of radiation recorded at all the times of the day compared with the global determinants which guarantee non- ionized radiation-free safe zones between 0.50 and 1.70 μSv/y [13], although some measured values larger than the value of 1.70 μSv/y; however, all means of the radiation levels fall within global limit. It has no harmful effects on the health of the people who live near communication towers, as shown in Fig. 2.

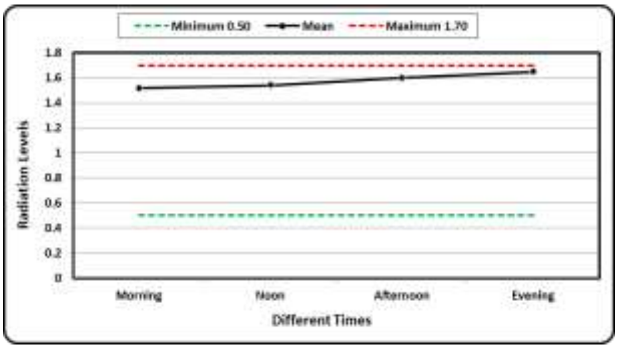

Figure 2. The means of recorded radiation levels at all times of the day within the fixed global limit of radiation levels 1.70 μSv/y.

A One-Sample t-test was used to verify statistically the absence of significant differences among the recorded means of radiation at 10 m distance from the towers at different times of the day (morning, noon, afternoon, and evening) and the maximum global limit. The results are listed in Table 4.

Table 4. t-test of the difference between the means of radiation levels recorded at different times at 10 m distance from the towers and the globally highest value of the radiation level 1.70 μSv/y

Times	t-test	Degree of freedom	Mean–limit difference	p-value
Morning	-2.052	11	-0.1816	0.065
Noon	-1.937	11	-0.1597	0.079
Afternoon	-0.673	11	-0.1013	0.232
Evening	-2.503	11	-0.1962	0.515

The t-test shows the p-value for all differences between the radiation levels means at each time, and the highest globally determined value 1.70 μSv/y, was greater than the significant level 0.05. The result showed no statistically significant differences between the means of the radiation levels recorded and the highest global value of the radiation level. Since all indicators of differences in the Table above were negative, the mean values of the measured radiation levels at all times are less than what was determined globally; hence lie within the limits of the non-ionized radiation-free zones. From what has been mentioned so far, the hypothesis that "the recorded radiation rates at different times of the day at 10 m distance from the communication towers lies within the fixed global determinants of the non-ionized radiation-free safe zones" has been verified.

Hypothesis 3: the levels of the recorded radiation for different areas on the geographical map lie within the fixed global determinants of the non-ionized radiation-free safe zones.

The results show that the mean of the recorded radiation levels on the geographical maps for all the areas was 1.5038 μSv/y with a standard deviation of 0.2715 μSv/y. One can notice that the mean of the radiation levels is within the fixed global radiation levels between 0.05 and 1.70 μSv/y. The One-Sample t-test has been used to verify this statistically to show the difference between the recorded mean of the radiation levels on the geographical map and what was determined globally, as the highest 1.70 μSv/y. It can notice that the p-value of the difference in means was less than the significant level of 0.05; this shows a statistically significant difference between them. The negative sign in the Table of the difference means that recorded radiation levels on the geographical map are too much less than the highest globally determined value 1.70 μSv/y; it is at the same time greater than the lowest globally defined as the lowest 0.05 μSv/y; hence, it lies within the non-ionized radiation-free safe zones. Therefore, the third hypothesis, "which states that the recorded radiation levels for different areas on the geographical map lie within the fixed global determinants of the non-ionized radiation-free safe zones," has been verified.

Hypothesis 4: there are no statistically significant differences between the means of the recorded radiation levels in different investigated areas at 10 m distance from the towers with other times of the day [15].

The statistical analysis of this hypothesis shows that; the means of the radiation levels recorded in all the investigated areas were close to each other, the least value for the recorded radiation level at different times was 1.0512 μSv/y in the Zones (Somer tower 4, Ashur tower 2, Sinharib tower 2, Kalih tower 1, Akad). In contrast, the highest recorded value was 1.8396 μSv/y in all Zones except Somer Qr the Towers 3 and 4. The highest means of the recorded radiation were 1.4673 and 1.7520 μSv/y with standard deviations 0.1314 and 0.1239 μSv/y in Somer tower 1 and Sinharib tower 2, respectively. In both Rasin and Akad Zones, the least means were 1.7739 μSv/y with standard deviations 0.2981 and 0.1239 μSv/y, respectively. Statistically, F-test was used to verify that there are no statistically significant differences between the means of the emitted recorded radiation per year from the towers in different areas by implementing a one-way analysis of variance. The results were:

Table 5. ANOVA table for emitted radiation rates (μSv/y) from the towers in the investigated Zones at four different times of the day and 10 m distance from the towers

Variance sources	Degree of Freedom	Some of the Squares	Mean of Squares	F-value	p-value
Between areas	11	0.483	0.044	0.502	0889
Within areas (Error)	36	3.154	0.088		
Total	47	3.637			

Table. 5, shows that the p-value for the test is 0.889, which is greater than the significant level of 0.05, which indicates that there are no differences in statistical signification between the means of the recorded radiation levels at all the areas at 10 m distance from the towers at different times of the day. One post hoc has been used to statistically verify no significant statistical differences between every two means of the recorded radiation levels, which is the least significant difference test. It is clear from the results that the p-value for all the values of differences between the two means of radiation levels between every two areas was greater than the significant level of 0.05. This shows the absence of statistically significant differences between the means of the recorded radiation levels at 10 m from the towers at all times of the day. From what was stated so far, the fourth hypothesis states that "there are no statistically significant differences between the means of the recorded radiation levels in different investigated areas at 10 m distance from the towers and at different times of the day", verified.

Hypothesis 5: The levels of recorded radiation in different areas at 10 m distance from the communication towers lie within the global determinants of the safe non-ionized radiation-free zones.

The recorded radiation levels at all the zones were compared with 0.05 and 1.70 μSv/y the range of global secure safe non-ionized radiation-free zones. Some recorded measured values were greater than the highest global value. Still, the means of radiation levels recorded at the Zones are within the range of the global determinants except for Somer tower no. 1 and Sinharib tower no. 2. This is clear in Fig. 3.

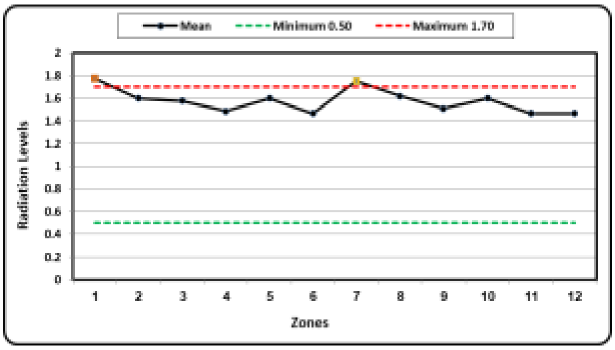

Figure 3. Most of the means of recorded radiation levels at the Zones are within the range of the fixed global determinants

As regards verifying the absence of statistically significant differences between the means of radiation levels at 10 m distance from the towers at different Zones and the fixed global determinants of radiation levels between 0.05 and 1.70 µSv/y, a t-test has been used for each sample to show the difference between the mean of the recorded radiation level at each Quarter and the highest globally determined 1.70 µSv/y. The results are in Table 6.

Table 6. t-test for differences between the recorded mean of radiation levels at 10 m distance from the towers at all investigated Zones and the fixed highest radiation levels as determined globally

Zones	t-test	degree of reedom	(Mean–global) difference	p-value
1	1.125	3	0.0739	0.343
2	-0.747	3	-0.1013	0.509
3	-0.994	3	-0.1232	0.393
4	-1.389	3	-0.2108	0.259
5	-0.747	3	-0.1013	0.509
6	-1.201	3	-0.2327	0.316
7	0.839	3	0.0502	0.453
8	-0.416	3	-0.0794	0.705
9	-1.142	3	-0.1889	0.336
10	-0.747	3	-0.1013	0.509
11	-1.561	3	-0.2327	0.216
12	-1.201	3	-0.2327	0.316

Table 6 above shows the p-value level for all the difference values between the mean radiation levels in each area. The highest determined globally 1.70 µSv/y was greater than the significant level of 0.05. This indicates the absence of statistically significant differences between the means of recorded radiation levels at different Zones at 10 m distance from the towers and the value of the highest radiation determined globally. This also indicates that the means of the radiation levels measured at all the zones do not statistically differ from the highest determined globally; they lie within the radiation-free zones [16,17].

Conclusions:

The results indicated no significant differences between the rates of radiation levels recorded at different times of the day at a distance of 10 meters from the towers for all the areas examined.

Radiation levels increase over time until they reach a peak in the evening; the results present radiation rates approximately close each to other in the evening.

Radiation rates recorded are within the global fixed limits for safe non-ionizing radiation-free zones, although some values of the measurements are greater than the globally specified.

The means of radiation levels are within the global limit, which means that there are no harmful effects on the health of people who live near communication towers.

Civilians may not always have that choice of where a phone tower should be built due to technological limitations in the wireless digital world. As a result, it may rely on quick fixes, such as recognized radiation protection elements that provide general safety from cell phone tower radiation. Radiation safety technology changes the nature of irradiation from a stationary wave to a variable waveform, making it harmless to humans.

Authors' declaration:

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are mine ours. Besides, the Figures and images, which are not mine ours, have been given the permission for re-publication attached with the manuscript.

- Ethical Clearance: The project was approved by the local ethical committee in University of Al-Hamdaniya.

Authors' contributions statement:

I. M. Y. Contributed to conceptions and the data analysis. R. A. B. Designed the Satalite figure and contributed to the drafting of MS. R. S. K. Contributed to the acquisition of data. M. H. K. Drafting the MS and revision of the manuscript.

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دراسة احصائية لكمية الاشعاع المتولد من ابراج الاتصالات في منطقة سهل نينوى بغديدا

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الخلاصة:

يقدم هذا البحث دراسة إحصائية للإشعاع المتولد من أبراج الاتصالات في منطقة سهل نينوى بغديدا. تم قياس شدة طاقة الإشعاع على بعد 10 أمتار من برج الاتصالات في مناطق مختلفة، باستخدام (PC XH-901 Dosimeter / Personal Dose Alarm / 1 Radiation Detector، dosage rate: 0.01 µSv/h إلى 150 µSv/h) لقياس كمية الإشعاع في أوقات مختلفة. تم قياس كثافة الطاقة ومقارنتها بالحدود القياسية المقدمة من السلطات الأخرى ، مثل اللجنة الدولية للحماية من الإشعاع. تم تحليل النتائج باستخدام SPSS الإصدار 26 لتنفيذ البيانات. تظهر النتائج أن متوسط مستويات الإشعاع المقاسة في جميع المناطق لا تختلف إحصائيًا عن أعلى القيم المحددة عالميًا (0.50-1.70 ميكرو سيفرت/س)؛ تقع داخل المناطق الخالية من الإشعاع. قد لا يكون لدينا دائمًا خيار مكان برج الهاتف المحمول. نتيجة لذلك، قد نعتمد على بعض الحلول السريعة، مثل عناصر الحماية من الإشعاع المعتمدة التي توفر حماية شاملة من إشعاع الأبراج المتنقلة. تعمل تقنية الحماية من الإشعاع المستخدمة في هذه السلع على تغيير طبيعة التشعيع من شكل موجة ثابت إلى شكل موجة متغير، مما يجعلها عديمة الفائدة.

الكلمات المفتاحية: أبراج الاتصالات، منطقة سهل نينوى، القيمة الاحتمالية، الإشعاع، البرنامج الإحصائي SPSS.