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# Assessment of Knowledge about Hazards of Ionizing Radiation among a Sample of Yemeni Population

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## Abstract

***Aim:*** The present study was carried out to assess the level of knowledge about ionizing radiation hazards among Yemeni patients in Sana'a city, republic of Yemen. ***Methods:*** A cross-sectional study of 669 questionnaires which tested patients 'information about ionizing radiation, its' harmful effects and protection from these effects. This study performed on participants who referred for radiological examinations to the radiology department of two academic hospitals. ***Results:*** There is a no significant difference in the level of knowledge between different age groups (p=.058) and gender (p=.179), However, there is a significant difference in the level of knowledge among different educational levels groups and between who work or study in the medical field or not (p=.000). The mean knowledge score was 7.0149 ± 2.12550, which indicate good level of knowledge between study participants. ***Conclusions:*** The study indicates a good level of knowledge between a sample of Yemeni population, and to elevated their knowledge to a higher level, the government, ministry of health, and hospitals have a responsibility to educate the population and increase their level of knowledge about ionizing radiation and its harmful effects.

**Keywords:** Ionizing Radiation, Radiation Hazards, Radiation Safety, Public Health, Yemen.



## INTRODUCTION

Radiation has become a part of modern living, reaching every segment of our society. It can be classified into ionizing and non- ionizing radiation [1].

Non-ionizing radiation contains enough energy to move the atoms in a molecule around them or make them vibrate, but not enough to remove electrons from the atoms [2]. Examples of this type of radiation are microwaves, visible light, and radio waves [3]. The second type, ionizing radiation, increases the risk of cancer or direct tissue damage when enough particles are broken down so that cells cannot function [4]. Ionizing radiation has many practical uses in medicine, research, and construction, but it is very dangerous if used incorrectly or with high doses [5]. Examples of this type are x- rays, 'gamma rays, and neutron radiation [6].

Ionizing radiation could be biologically damaging to living tissues [7]. It may directly damage the DNA of the living cell and indirectly by creating free radicals, which form new toxic substances, such as hydrogen peroxide ($H_2O_2$), which can lead to cellular alternations [8].

All individuals are exposed to ionizing radiation, both from natural and man-made radiation sources. X-rays are ionizing radiation used extensively in medical and dental practice. Even though they provide useful information and aid in diagnosis, they have the potential to cause harmful effects [1].

The harmful effects of ionizing radiation may be classified into deterministic and stochastic effects. Deterministic effect is more lethal to the tissue due to extensive killing of the cells. The severity of response is proportional to the dose. Whereas, the stochastic effect is individual cell damage, which in turn damages the DNA leading to carcinogenesis and heritable defects. Both dentists and patients are at high risk of stochastic effects as it has no dose threshold [9].

Radiology departments in health institutions use different imaging modalities: both ionizing radiation

(such as x-ray, fluoroscopy, mammography, and nuclear medicine and computer tomography) and non-ionizing radiations (such as ultrasound, magnetic resonance imaging) in the diagnosis of many medical problems and have significantly increased during the last years on worldwide for diagnostic and therapeutic purposes [10].

Radiation has both positive and negative influences, so it must let the public realize the correct awareness of radiation [11]. The level of knowledge and awareness among Yemeni patients about the concepts and implications of medical radiation is unknown and there is a need to understand it. Therefore; the present study was carried out to assess the level of knowledge about ionizing radiation hazards among Yemeni patients in Sana'a city, republic of Yemen.

## MATERIALS AND METHODS

A cross-sectional study performed between 15 August and 22 November 2024 among participants who referred for radiological examinations to the radiology department of two academic hospitals. Completed 669 questionnaires which tested patients 'information about ionizing radiation, its' harmful effects and protection from these effects. The questionnaire was filled by individually interviewing each of the participants of the sample population after seeking informed consent.

The questionnaire consists of 12 questions, which a combination of Yes-No and multiple-choices questions. It was divided into two sections: the first section consists of 4 questions included sociodemographic data; their age (18-25 years, 26-45 years, 46-65 years, and 66-90 years), gender, education level (no school degree, primary school, middle school, high school, university graduate, and higher education), and they are work or study in the medical field or not. The second section of questionnaire consists of 8 questions, which was a combination of yes-no-no idea and multiple-choice questions that assess participants' knowledge about radiation hazards, including the following questions: is there a natural source of ionizing radiation to which we are all exposed, is ionizing radiation dangerous to your health, would preventing or minimizing ionizing radiation exposure improve a person's health, do you perceive that x-ray in dentistry is harmful, is it necessary to adjust the dose of the radiation with respect to the age of the patient, do you think that x-ray imaging can cause cancer, do you think that x-ray imaging can cause fertility problems, do you think that dental x-ray imaging is suitable for pregnant women, which of the following modalities uses ionizing radiation (Ultrasound, MRI, CT and no idea), which of the following imaging modalities are safe for pregnant women (Ultrasound, CT, MRI, no idea), which human body organs highly sensitive to radiation (Gonads, Kidney, Thyroid, no idea), in your opinion, which of the following procedure is associated with a greater dose of radiation (CT Scan, Chest X-ray, Skull X-ray, no idea).

### Statistical Analysis

The knowledge of participants was evaluated by calculating the scores for correct answers. Each correct response was given one point. Data were represented in terms of frequencies and valid percentages for categorical variables. Mean and standard deviations values were used to describe the numerical variables. A one-way analysis of variance (ANOVA) test and independent samples t-test were used to compare numerical variables between the subgroups. All *p*-values <0.05 were considered as statistically significant. Information gathered was entered into computer and data was processed and analyzed using version 23 of Statistical Package for Social Science (SPSS). The total knowledge score was calculated for included questions evaluating knowledge about radiation hazards. The mean for total score was compared over different demographic data and influencing factors using one-way ANOVA at the level of significance p-value <0.05.

## RESULTS

The lists of sociodemographic characteristics of participants are summarized in Table 1. The study included 669 participants, females were 429 (64.1%) and males 240 (35.9%). The percentage of age was 30.0 % for 18-25 years, 45.9% for 26-45 years, 17.5% for 46-65, and 6.6% for 66-90 years. The age group 26- 45 years had more participants. Education level was no school degree (11.4%), primary school (7.3 %), middle school (12.1 %), high school (20.9 %), university graduate had most common percentage (41.1 %), and higher education (7.2 %). The majority (55.5%) of participants were not work or study in medical field.

**Table 1: Sociodemographic characteristics of participants**

| Socio-demographic characteristics | | Frequency | Percentage |
|---|---|---|---|
| **Age in years** | 18-25 | 201 | 30.0 |
| | 26-45 | 307 | 45.9 |
| | 46-65 | 117 | 17.5 |
| | 66-90 | 44 | 6.6 |
| | **Total** | **669** | **100.0** |
| **Gender** | Male | 240 | 35.9 |
| | Female | 429 | 64.1 |
| | **Total** | **669** | **100.0** |
| **Education** | No school degree | 76 | 11.4 |

| Socio-demographic characteristics | | Frequency | Percentage |
|---|---|---|---|
| | Primary school | 49 | 7.3 |
| | Middle school | 81 | 12.1 |
| | High school | 140 | 20.9 |
| | University graduate | 275 | 41.1 |
| | Higher education | 48 | 7.2 |
| | **Total** | **669** | **100.0** |
| **Work or study in the medical field** | Yes | 298 | 44.5 |
| | No | 371 | 55.5 |
| | **Total** | **669** | **100.0** |

Distribution of (yes-no-no idea) answers of the survey are summarized in Table 2. Most of participants (60 %) believe that there is a natural source of ionizing radiation to which we are all exposed, 228 of them (34.1 %) don't believe that, and 39 (5.8 %) had no idea. When participants were asked is ionizing radiation dangerous to health or not; 542 (81 %) of them knew that the ionizing radiation is dangerous to health, and 52 (7.8 %) had no idea. There were 491 (73.4 %) of the participants who answered that the preventing or minimizing ionizing radiation exposure improve a person's health, and 97 (14.5 %) had no idea. Only 277 (41.4 %) of the participants knew that the x-ray used in dentistry is harmful and they answered yes, 47.5 % answered no, and 11.1 % had no idea. Regarding the radiation dose adjustment with respect to the age of the patient, 72 % of the participants answered yes, 6.1 % answered no, and 21.8 % had no idea. The majority of the participants (74.3 %) known that x-ray imaging could cause cancer, 11.7 % did not believe that and 14.1 % had no idea. There were 64.1 % of the participants answered yes when asked if the x-ray imaging can cause fertility problems, 23.3 % answered no, and 23.8 % had no idea. A slight majority of the participants (55.2 %) answered no when asked if the dental x-ray imaging is suitable for pregnant women, 12.1 % answered yes, and 21.5 % had no idea.

**Table 2: Distribution of the (yes-no- do not know) answers**

| Questions | | Frequency | Percentage |
|---|---|---|---|
| **Is there a natural source of ionizing radiation to which we are all exposed?** | Yes | 402 | 60.0 |
| | No | 228 | 34.1 |
| | Do not know | 39 | 5.8 |
| **Is ionizing radiation dangerous to your health?** | Yes | 542 | 81.0 |
| | No | 75 | 11.2 |
| | Do not know | 52 | 7.8 |
| **Would preventing or minimizing ionizing radiation exposure improve a person's health?** | Yes | 491 | 73.4 |
| | No | 81 | 12.1 |
| | Do not know | 97 | 14.5 |
| **Is it necessary to adjust the dose of the radiation with respect to the age of the patient?** | Yes | 482 | 72.0 |
| | No | 41 | 6.1 |
| | Do not know | 146 | 21.8 |
| **Do you think that X-ray imaging can cause cancer?** | Yes | 497 | 74.3 |
| | No | 78 | 11.7 |
| | Do not know | 94 | 14.1 |
| **Do you think that X-ray imaging can cause fertility problems?** | Yes | 429 | 64.1 |
| | No | 81 | 12.1 |
| | Do not know | 159 | 23.8 |
| **Do you perceive that X-ray in dentistry is harmful?** | Yes | 277 | 41.4 |
| | No | 318 | 47.5 |
| | Do not know | 74 | 11.1 |
| **Do you think that dental X-ray imaging is suitable for pregnant women?** | Yes | 156 | 23.3 |
| | No | 369 | 55.2 |
| | Do not know | 144 | 21.5 |

Distribution of multiple-choices answers of the survey are summarized in Table 3. Many of participants (30 %) known that CT used ionizing radiation, and 39.6% had no idea. Most of the participants (71.3%) believed that Ultrasonography could be used safely for pregnant women, only 1.2 % believed that MRI was safe during pregnancy, and 18.4% of them had no idea. The percentage of participants who believed that thyroid is the highly sensitive organ to radiation was 33.8%, and 36.6% of them had no idea. There were 38.7 % of the participants who answered that CT scan is associated with a greater dose of radiation, percentage of chest x ray

and skull x ray were 29.4% and 25.6 % respectively, and 6.3 % of them had no idea.

**Table 3: Distribution of the multiple-choice answers**

| Questions | | Frequency | Percentage |
|---|---|---|---|
| **Which of the following modalities uses ionizing radiation?** | Ultrasound | 93 | 13.9 |
| | MRI | 110 | 16.4 |
| | CT | 201 | 30.0 |
| | No idea | 265 | 39.6 |
| **In your opinion, which of the following procedure is associated with a greater dose of radiation?** | CT scan | 259 | 38.7 |
| | Chest X-ray | 197 | 29.4 |
| | Skull X-ray | 171 | 25.6 |
| | No idea | 42 | 6.3 |
| **which of the following imaging modalities are safe for pregnant women?** | Ultrasound | 477 | 71.3 |
| | CT | 61 | 9.1 |
| | MRI | 8 | 1.2 |
| | No idea | 123 | 18.4 |
| **Which human body organs highly sensitive to radiation?** | Gonads | 126 | 18.8 |
| | Kidney | 72 | 10.8 |
| | Thyroid | 226 | 33.8 |
| | No idea | 245 | 36.6 |

Table 4 illustrate a comparison of total knowledge score over different socio-demographic data, there is a no significant difference in the level of knowledge between different age groups (p=.058) and gender (p=.179), However, there is a significant difference in the level of knowledge among different educational levels groups and between who work or study in the medical field or not (p=.000).

**Table 4: Comparison of total knowledge score over different socio-demographic data**

| Socio-demographic characteristics | | N | Mean | S. D | P-Value |
|---|---|---|---|---|---|
| **Age in years** | 18-25 | 201 | .5817 | .18180 | .058 |
| | 26-45 | 307 | .5964 | .17180 | |
| | 46-65 | 117 | .5833 | .18794 | |
| | 66-90 | 44 | .5189 | .15129 | |
| **Gender** | Male | 240 | .5969 | .182 | .179 |
| | Female | 429 | .5777 | .173 | |
| **Education** | no school degree | 76 | .01959 | .17078 | .000 |
| | primary school | 49 | .02591 | .18136 | |
| | middle school | 81 | .02140 | .19262 | |
| | high school | 140 | .01412 | .16703 | |
| | university graduate | 275 | .00966 | .16021 | |
| | higher education | 48 | .01743 | .12074 | |
| **Work or study in the medical field** | Yes | 298 | .636 | .174 | .000 |
| | No | 371 | .542 | .168 | |

***p-value significance at the level of <0.05.**

## DISCUSSION

This study was the first study which carried out in a sample of Yemeni population to assess the knowledge of population about the ionizing radiation and its' harmful effects. This study was conducted in participants who were attended at radiology department of Al- Thawra and Al-Jumhurii hospitals which are the biggest teaching hospitals in sana a' city of republic of Yemen.

Questionnaires was filled by individually interviewing each of the participants of sample population because they are attended from different social backgrounds including some with minimum levels of education who needed help in understanding the questionnaire.

The higher number of female participants (64%) in this study is supported by the fact that generally majority of the participants attending for service in these hospitals are females. The age group 26-45 years had the highest number of participants (45%). About 41% of study population have a university graduate because the hospitals of study are teaching hospitals, and there are many participants who work in the medical field (44.5%), and 55.5 % who are not.

In the present study the mean knowledge score was 7.0149 ± 2.12550, which indicate good level of knowledge between study participants. The level of participants' knowledge toward ionizing radiation was evaluated by another studies, Almatared *et al.*, [12] showed that level of knowledge of 375 patients was low in Nijran city, Saudi Arabia. Another study in Bahrain showed that the mean score for the knowledge section was below average [13].

There is a no significant difference in the level of knowledge between different age groups and gender, However, there is a significant difference in the level of knowledge among different educational levels groups and between who work or study in the medical field or not. These finding were in contrast to Alshammari study [13] who described a significant difference in the level of knowledge between different age groups, and no significant difference in the level of knowledge among different educational levels. This difference may be related to small sample size of the other study which decrease the reliability of their results.

Approximately 60 % of the participants had good knowing about natural background radiation, and 81% of them believe that the ionizing radiation is harmful to the health, and minimizing the dose will improve the health (73.45%). Moreover, 72% of the population believe that the dose of radiation should be adjusted according to the age of the patient. Knowledge about natural background radiation may be related to social media and its positive effects on the education of the general population.

With regard to adverse effects of radiation 74% of participants think the x-ray can cause cancer, this percentage is higher than other studies by Aldossari [14] and Asefa [15], in which 20.8% and 64% respectively indicated that the cancer could be a consequence of radiation imaging.

Regarding the x- ray used in dentistry, about 47.5% of population answer it is not harmful, this is related to the distribution of the wrong idea between the population which is, the dose of x- ray used in dentistry is low, and not harmful. Moreover, this concept was affected on the answer of most of them (55.2%), that the dental x-ray is suitable and not harmful for pregnant women.

Most of participants 39.6% had no idea about which modality using ionizing radiation, 30% of them answer that the CT is the imaging modality which using ionizing radiation, and 13.9 % of the participants realized that the US use ionizing radiation, while, 16.4% of the patients believed MRI use ionizing radiation. It was a about 70% over 669 participants did not know that ionizing radiation is used in CT and US and MRI used non-ionizing radiation. These results are nearly similar to results found by Aldossari study [14] which found 19.0% of the participants realized that the US use ionizing radiation, 18.0% of the them believed MRI use ionizing radiation, while 31.8% of them had no idea about which modality use ionizing radiation. Furthermore, 38.7% of participants know that the CT is associated with a greater dose of radiation, and this result is similar to another study carried out in Saudi Arabia [17].

Most of the participants (71.3 %) had knowledge about safely of US used for pregnant women. In contrast to Asefa study [15] in which 90.2% of participants had no knowledge about which modality could be used safely for pregnant women, followed by Düzeyleri study in Turkey (73.2%) [16], and then Aldossari study [14] (44.5%). This shows that our patients more aware of this issue, and that might be due to most of the women follow up by the US during the pregnancy. Very few (1.2%) participants answered that MRI safe for pregnant women because it is used only in specific situation not related to pregnancy.

Regarding the sensitivity of organs to ionizing radiation, 36.6 % of population have no idea which organ is more sensitive to radiation, 33.8% of them answered that the thyroid is highly sensitive organ of the body to radiation, and only 18.8% of them answered that the gonads is the highly sensitive organ to radiation.

## CONCLUSION

The study indicates a good level of knowledge between a sample of Yemeni population, and to elevated their knowledge to a higher level, the government, ministry of health, and hospitals have a responsibility to educate the population and increase their level of knowledge about ionizing radiation and its harmful effects.

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