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(Research Article)

Evaluation of Immunoglobulin Levels in X- Ray Technicians among Different Hospitals in Basrah Province -Iraq

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Abstract

Background: One of the most important physical agents utilized in the modern practice of medicine is ionization radiation, and it is now indispensable for diagnostic and therapeutic purposes. Objective: To examine the immunological changes that occur in the technicians in radiation-related professions who have had prolonged exposure to radiation.

Methodology: This cross sectional study involved two groups; (70) occupationally exposed X-ray technicians of three major teaching hospitals and five private diagnostic centers in Basra Province, and (35) unexposed control. The concentrations of immunoglobulins (IgM, IgG, and IgA) by automated Abbott Architect Ci4100 analyzer.

Results: The results of the current study demonstrated significant decrease ($p \leq 0.05$) in serum IgM concentrations among X-ray technicians compared with the unexposed control group. The median IgM level was 59.80 mg/dL (IQR: 41.20-106.10) in X-ray technicians versus 106.10 mg/dL (IQR: 76.70-145.30) in control. In contrast, serum IgA and IgG concentrations didn't show any significant differences between both groups. According to the years of work, the present data showed a significant increase ($p \leq 0.05$) in the median of IgA and IgM concentrations among x-ray technicians for less than 10 years group103.60 mg/dL (IQR: 94.90-174.90) and 213.85 mg/dL (IQR:185.10-382.15), respectively compared to more than 10 years group 51.50 mg/dL (IQR: 32.40-81.9) and 111.80 mg/dL (IQR:74.10-199.20) respectively.

Conclusion: Chronic occupational exposure to X-ray radiation may influence humoral immunity through suppression of IgM levels among radiology technicians. Prolonged exposure (more than 10 years) was associated with further reduction in IgM and IgA concentrations suggesting cumulative immunological effects of long–term low dose radiation exposure.

Keywords: Occupational Radiation; X-ray; IgM; IgG; IgA

1. Introduction

One of the most important physical agents utilized in the modern practice of medicine is ionization radiation, and it is now indispensable for diagnostic and therapeutic purposes.[1, 2] The application of the diagnostic X-ray procedures such as computed tomography (CT), fluoroscopy and interventional radiology can improve disease diagnosis, patient management and clinical outcomes.[3, 4] These applications are widely used, which also contributes to the radiation exposure of healthcare workers, and specifically the radiological technicians, radiologists and interventional radiologists who are the most exposed category, because of the numerous number of radiology environments and the large number of radiation sources that can be encountered during their daily activities.[2]

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In developed countries, over half of manmade exposures to radiation are related to healthcare activities.[2] According to the International Commission on Radiological Protection (ICRP), the yearly occupational exposure limits are 20 mSv/year with a maximum of 50 mSv per year averaged over a period of 5 years.[1] However, the consequences of prolonged low level exposures to humans are not well established and more studies are needed to determine the potential health risks of occupational radiation exposure to health care workers.[5, 6]

Some previous studies have attempted to evaluate immune system alterations of health care workers who have been occupationally exposed to radiation. Alnahhal *et al*., noted immunological alterations in radiographer occupationally exposed to ionizing radiation and suggested that occupational exposure might affect immune status by means of oxidative and inflammatory pathways.[7] From their results, Lumniczky *et al.,* suggested that low dose ionizing radiation might be involved in the regulation of the immune system, in oxidative stress and in altered cytokine production, as well as in the disruption of the differentiation of lymphocytes, resulting in an immune dysfunction.[8] They suggested that doses of non-determinism might still impact immune fitness, and in fact, cause chronic inflammatory states, and noted a possible effect on the dynamics of immune cells and hematopoietic stem cells that may shift over time, affecting immune responses. However, there have been some studies that haven't yielded the same results.

Ehrahimyan *et al*., compared radiology technicians and non-exposed groups and found no statistically significant differences between the serum levels of each of the immunoglobulin types (IgA, IgG and IgM).[9] Low levels of radiation exposure during diagnosis are not the risk of any detectable immune alteration and the authors stated this. Such discrepancies suggest the relationship between radiation exposure and humoral immunity in the long term is unresolved and needs to be explored in more detail. Several studies have examined the association between radiation dose and immune effects. These studies have yielded mixed results. Liu *et al*., carried out a study on low-dose radiation workers, and studied the ionizing radiation sensitivity index and radiation dose-effect relationship, revealing that the changes of lymphocyte count in radiation workers were related to the cumulative occupational dose.[10]

Their study highlighted the need to monitor immune parameters in radiation workers, especially those with long-term occupational exposure. Wang *et al*., studied the impact of occupational low-dose radiation on the expression of immune checkpoints in medical radiologists, and concluded that the amount of cumulative radiation dose correlated with the expression of CTLA-4 and TIM-3 in peripheral blood T-lymphocytes.[11] More importantly, their study found that smoking and body mass index (BMI) were modifying factors that could worsen radiation-induced immune dysfunction; therefore, the health concerns of radiation exposure should not be ignored when there are individual susceptibility factors. Recent studies have identified multiple immunological dysfunction and immunosuppressive pathways induced by long-term low-dose radiation.[12] The present study aimed to examine the concentrations of the serum immunoglobulin level in X-ray technicians in Basrah province, Iraq, due to occupational exposure to ionizing radiation.

2. Materials and Methods

2.1. Study design

This cross sectional study involved two groups; (70) occupationally exposed X-ray technicians (33 male and 37 female) and (35) unexposed control (18 male and 17 female), . The target population for X-ray technicians selected from the radiology departments especially (X-ray unit) of three major teaching hospitals and five private diagnostic centers in Basrah Province. The study conducted between October 2023 to May 2024. Daily Hours of exposure to x- ray was 9.69±2.81 hours. X-ray technicians were divided according to the years of work into two groups; (35) less than 10 years group and (35) more than 10 years group as well as according to gender into female and male and subdivided according to the hours of exposure to X-ray into less than 6 hours group and more than 6 hours group.

2.2. Inclusion criteria

Participants(X-ray technicians) must be had at least two years with a minimum occupational employment in radiology departments and their aged between 22-56 years old While non exposed X-ray must be with no occupational or medical exposure to ionizing radiation and no history of radiation therapy and their aged matched with x-ray technicians.

2.3. Exclusion criteria

Subjects with anemia, diabetes mellitus, cardiopulmonary disease, acute or chronic infection, autoimmune disease, malignancy , pregnancy or lactation, chronic kidney disease , chronic liver disease , corticosteroid use, recent vaccination (within 2 weeks of blood collection) were all excluded.

2.4. Blood specimens collection

Venipuncture was used to draw blood samples from 80 individuals. A syringe was used to draw five milliliters of blood. This material was placed in a test tube that had been sterilized and allowed to coagulate. After centrifuging the sample for 15 minutes at 4000 rpm, the serum was extracted. The obtained serum samples were stored at -20 ºC until immunoglobulin (IgA, IgM, and IgG) analysis.

2.5. Determination of serum levels of IgA, IgM, and IgG

The immunoglobulins assay kits were supplied by Abbott laboratories, USA measured by automated Abbott Architect Ci4100 analyzer.

2.6. Statistical analysis

The normality of data was checked through Shapiro-Wilk test. Statistical Package for social sciences (SPSS) software version 25. Since immunoglobulin concentrations were not normally distributed data were expressed as median and interquartile range (IQR: 25-75%) comparison between two independent groups were perform using Mann-Whitney-test was used categorical variables such as gender and demographic characteristics were presented as frequency and percentages [n(%)] and comparison were carried out using the Chi –square (χ^2). A significant probability *p*-value was considered as 0.05 or less. The quantitative variables were evaluated in the form of mean ± Standard Deviation.

3. Results

The demographic characteristics of the study are presented in (Table 1). The mean age of X-ray technicians and non-exposed control didn't show a significant differences as well as gender as well as gender and smoking status.

Table 1 The demographic characteristic of the study

Variables	X-ray technicians (n=70)	X-ray non exposed n=35	*p*-value
Age (mean ± SD)	36.19±7.40	34.88±6.98	0.44
Gender (n%)			
Female	37 (48%)	17 (56.7%)	p=0.45 X^2=0.56
Male	33 (52%)	18 (43.3%)	
Smoking status			
Smoker	2 (2.9%)	3 (8.6 %)	p= 0.19 X^2=1.67
Non smoker	68 (97.1%)	32 (91.4%)	

The results of the current study demonstrated a significant decrease ($p \leq 0.05$) in serum IgM concentrations among X-ray technicians compared with the unexposed control group. The median IgM level was 59.80 mg/dL (IQR: 41.20-106.10) in X-ray technicians versus 106.10 mg/dL (IQR: 76.70-145.30) in control. In contrast, serum IgA and IgG concentrations didn't show any significant differences between both groups as in (Table 2).

Table 2 Comparison of serum immunoglobulins concentrations (mg/dL) between X-ray technicians group and unexposed control group

Parameters	Groups	N	Median (IQR: 25-75%)	*p*-value
IgM (mg/dL)	X- ray technicians	70	59.80 (41.20-106.10)	0.02*
	X-ray Non technicians	35	106.10 (76.70-145.30)	
IgA (mg/dL)	X- ray technicians	70	189.70 (145.50-246.10)	0.50
	X-ray Non technicians	35	208.80 (171.30-257.40)	
IgG mg/dL	X- ray technicians	70	867.20 (694-1054.30)	0.37
	X-ray Non technicians	35	977.80 (694-1255)	

n= number of sample, *= Significant difference at ($p \leq 0.05$), IQR =Interquartile Range, IgM =immunoglobulin M, IgA= Immunoglobulin A, IgG= Immunoglobulin G, mg/dL= milligram per deciliter

According to the years of work (Table 3), the present data showed a significant increase ($p \leq 0.05$) in the median of IgA and IgM concentrations among x-ray technicians for less than10 years group103.60 mg/dL (IQR: 94.90-174.90) and 213.85 mg/dL (IQR:185.10-382.15), respectively compared to more than 10 years group 51.50 mg/dL (IQR: 32.40-81.9) and 111.80 mg/dL (IQR:74.10-199.20) respectively.

Table 3 Comparison of serum immunoglobulin concentrations (mg/dL) among X-ray technicians according to years of work

Parameters	Groups	N	Median(IQR: 25-75%)	*p*-value
IgM (mg/dL)	Less than 10 years	35	103.60 (94.90-174.90)	0.001*
	More than 10 years	35	51.50 (32.40-81.9)	
IgA (mg/dL)	Less than 10 years	35	213.85 (185.10-382.15)	0.009*
	More than 10 years	35	111.80(74.10-199.20)	
IgG (mg/dL)	Less than 10 years	35	960.75 (694- 1287)	0.112
	More than 10 years	35	694 (361.80-1054.30)	

n= number of sample, *= Significant difference at ($p \leq 0.05$), IQR =Interquartile Range, IgM =immunoglobulin M, IgA= Immunoglobulin A, IgG= Immunoglobulin G, mg/dL= milligram per deciliter

According to the hours of exposure to X-ray both groups (less than 6 hours and more than 6 hours) didn't exhibited significant differences as shown in (Table 4) . As well as in (Table 5) there wasn't a significant difference according to gender.

Table 4 Comparison of serum immunoglobulin concentrations (mg/dL) among X-ray technicians according to hours of exposure to X-ray

Parameters	Groups	N	Median(IQR: 25-75%)	*p*-value
IgM (mg/dL)	Less than 6 hours	35	70.85 (38.20-157.90)	0.91
	More than 6 hours	35	101.10 (53.57-112.45)	
IgA (mg/dL)	Less than 6 hours	35	199.15(181.55-297.40)	1.00
	More than 6 hours	35	176.35 (101.97-283.22)	
IgG (mg/dL)	Less than 6 hours	35	631.90 (361.80-1054.30)	0.27
	More than 6 hours	35	762.75(694-1163.55)	

n= number of sample, IQR =Interquartile Range, IgM =immunoglobulin M, IgA= Immunoglobulin A, IgG= Immunoglobulin G, mg/dL= milligram per deciliter

Table 5 Comparison of serum immunoglobulin concentrations (mg/dL) among X-ray technicians according to gender

Parameters	Groups	N	Median(IQR: 25-75%)	*p*-value
IgM mg/dL	Female	33	59.80 (38.75-178.80)	0.73
	Male	37	96.10 (51.55- 132.70)	
IgA mg/dL	Female	33	199.20 (136.60-539.75)	0.37
	Male	37	189.70 (100.05-264.65)	
IgG mg/dL	Female	33	1054(527.9-1053.3)	0.67
	Male	37	694 (389.20-1093.65)	

n= number of sample, IQR =Interquartile Range, IgM =immunoglobulin M, IgA= Immunoglobulin A, IgG= Immunoglobulin G, mg/dL= milligram per deciliter

4. Discussion

The present study was undertaken to assess the effect of occupational X-ray exposure on humoral immune function in radiological technicians. It was concluded that there was significant changes in the level of immunoglobulin in the X-ray exposed workers. The authors reported that the level of IgM in the serum of the X-ray workers group was significantly lower than that of the unexposed group ($p \leq 0.05$). This is in agreement with previous knowledge that radiation exposure causes immunodysfunction in workers with X-ray exposure.[8, 13] The marked reduction in the levels of IgM in the present study is in accordance with the previously reported immunodysfunction in X-ray technicians, as they observed statistically decreased levels of total IgA and total IgM in X-ray technicians as compared to unexposed technicians particularly among smoking X-ray technicians.[14] Since it is synthesized by short-lived plasmablasts and plasma cells that respond to recent antigen stimulation, the level of IgM is sensitive to ongoing primary immune responses and B-cell activation, making it an important marker of B cell activation.[15] IgG and IgA, on other hand, are secreted by long-lived plasma cells in protected bone marrow niche and mucosal lymphoid tissues, respectively, both of which are more radioresistant to radiation-induced apoptosis.[16, 17]

The suppression of IgM and the reduction in IgA in the radiation workers can be attributed to activation of DNA damage response pathways in B lymphocytes and consequent apoptosis. There are two mechanisms by which ionizing radiation damages DNA by ionizing critical biomolecules and by producing reactive oxygen species (ROS).[18] Damage to the DNA can occur in the form of double-strand breaks (DSBs) or single-strand breaks (SSBs), which activate sensor proteins such as ataxia telangiectasia mutated (ATM) and ATM and Rad3-related (ATR) kinases.[19] Once ATM and ATR are activated, they also activate downstream signaling pathways that facilitate the phosphorylation of p53 which functions as the "guardian of the genome", leading to cell cycle arrest or cell death via the activation of pro-apoptotic genes like BAX and PUMA.[19, 20] In addition to catalyzing direct damage to DNA, lipids and proteins, the generation of ROS from the radiolysis of water is an important indirect pathway leading to radiation-induced cellular damage, and ROS can diffuse into the cell, causing damage to DNA, lipids and proteins.[18]

Among X-ray workers with >10 years of occupational exposure, the median value of IgA and IgM were significantly decreased ($p \leq 0.05$) when compared with those workers with <10 years of occupational exposure, as obtained from the present data. This discovery shows duration-dependent impact of occupational radiation on humoral immunity, which implies that the more occupational exposure, the more the B-cell function and antibody production is impaired.[21, 22] The chronic exposure to low dose radiation characteristic of diagnostic radiology and the cumulative effect of repeated occupational exposures could result in continuing changes in immune homeostasis.[8, 11] The progressive immune system suppression associated with long working experience (>10 years) suggests that the immune system is deteriorating with increasing radiation exposure, which may be due to accelerated immune aging or chronic activation of apoptotic pathways in B-cells.[12] Such a time-dependency between years of exposure and immunological changes has also been observed in previous occupational cohort studies, showing that a longer time of exposure was correlated with greater immunological changes of immune markers.[10, 23]

Recently, the notch signaling pathway has been found to play a critical role in regulating B-cell development and function in response to radiation-induced stress. Notch signaling plays an important role in B-cell mediated immune responses and is critical for maintaining immune function.[24] Progressive depletion of B-cell populations and impaired bone marrow function may result from chronic occupational exposure to radiation and may underlie changes in immunoglobulin production. Bone marrow, spleen and thymus are important sites of immune cell production and maturation, and are particularly vulnerable to radiation damage.[18, 25]

Limitation

The study was limited by the relatively small samples size and absence of personal dosimetry records which prevented correlation between cumulative radiation dose and immunoglobulin alterations.

5. Conclusion

Chronic occupational exposure to X-ray radiation may influence humoral immunity through suppression of IgM levels among radiology technicians. Prolonged exposure (more than 10 years) was associated with further reduction in IgM and IgA concentrations suggesting cumulative immunological effects of long–term low dose radiation exposure.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

The study protocol was approved by the Research Ethics Committee Directorate , Basrah, Iraq. The study procedures complied with the ethical standards of the Declaration of Helsinki and all participants information was kept.

Statement of informed consent

Written informed consent was obtained from all participants before enrollment.

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References

[1] Lopes R, Teles P, Santos J. A systematic review on the occupational health impacts of ionising radiation exposure among healthcare professionals. J Radiol Prot. 2025;45(2):021002.

[2] Baudin C, Vacquier B, Thin G, Chenene L, Guersen J, Partarrieu I, et al. Occupational exposure to ionizing radiation in medical staff: Trends during the 2009–2019 period in a multicentric study. Eur Radiol. 2023;33(8):5675-5684.

[3] Bolbol SA, Zaitoun MF, Abou El-Magd SA, Mansour HH, Amin AA. Healthcare workers exposure to ionizing radiation: Oxidative stress and antioxidant response. Int J Occup Environ Health. 2021;25(2):89-98.

[4] World Health Organization. Ionizing radiation and health effects. Geneva: World Health Organization; 2023. Available from: https://www.who.int

[5] Cassatt DR, Winters TA, PrabhuDas M. Immune dysfunction from radiation exposure. Radiat Res. 2023;200(4):389-395.

[6] Mansouri B, Moradi A, Saba F. Blood oxidative stress parameters in hospital workers occupationally exposed to low doses of ionizing radiation: A systematic review and meta-analysis. Heliyon. 2024;10(22):e39989.

[7] Alnahhal M, Alajerami YSM, Jaber S, Abushab K, Najim A. Radiation exposure and immunity status of radiographers at government hospitals. Int J Med Sci Public Health. 2016;6(2):1.

[8] Lumniczky K, Impens N, Armengol G, Candéias S, Georgakilas AG, Hornhardt S, et al. Low dose ionizing radiation effects on the immune system. Environ Int. 2020;149:106212.

[9] Ehrahimyan S, Montazerabadi A, Masoumi A, Keshtkar M. Assessment of some factors of cellular and humoral immunity in radiology workers. Radiat Environ Biophys. 2021;60(3):501-505.

[10] Liu G, Zhang R, Li Y, Wu XQ, Niu LM, Liu YY, et al. Study of low-dose radiation workers ionizing radiation sensitivity index and radiation dose-effect relationship. Health Phys. 2022;123(4):362-371.

[11] Wang C, Zhu Y, Gao X, Ren W, Liu Y, Sun Q. Occupational low-dose radiation affects the expression of immune checkpoint of medical radiologists. Int J Environ Res Public Health. 2022;19(12):7105.

[12] Zhang Y, Li R, Li X, Li R, Lu T, Zhong X, et al. The impact of long-term low-dose ionizing radiation on human health: Risks and protective measures. Front Med. 2026;13:1628683.

[13] Haag F, Janicova A, Xu B, Powerski M, Fachet M, Bundkirchen K, et al. Reduced phagocytosis, ROS production and enhanced apoptosis of leukocytes upon alcohol drinking in healthy volunteers. Eur J Trauma Emerg Surg. 2022;48(4):2689-2699.

[14] Godekmerdan A, Aydın A, Eken A, Yilmaz E. The effects of occupational exposure to low-level ionizing radiation on the immune system. Photochem Photobiol. 2004;80(3):412-416.

[15] Vidarsson G, Dekkers G, Rispens T. IgG subclasses and allotypes: From structure to clinical relevance. Front Immunol. 2014;5:520.

[16] Franiak-Pietryga I, Miyauchi S, Kim SS, Manocha S, Schuster M, Sinha R, et al. Activated B cells and plasma cells are resistant to radiation therapy. Int J Radiat Oncol Biol Phys. 2022;112(4):1029-1041.

[17] Gyuleva I, Djounova J, Rupova I. Impact of low-dose occupational exposure to ionizing radiation on T-cell populations and subpopulations and humoral factors included in the immune response. Dose Response. 2018;16(3):1559325818785564.

[18] Chen M, Amjad N, Wu Y, Sun Z, Sun Y. Radiation-induced immune modulation and inflammatory responses in human cells and tissues. Int J Mol Sci. 2026;27(5):2441.

[19] Zhang C, Liu J, Wu J, Ranjan K, Cui X, Wang X, et al. Key molecular DNA damage responses of human cells to radiation. Front Cell Dev Biol. 2024;12:1422520.

[20] Guo JJ, Liu N, Ma Z, Gong ZJ, Liang YL, Cheng Q, et al. Dose-response effects of low-dose ionizing radiation on blood parameters in industrial irradiation workers. Dose Response. 2022;20(2):15593258221105696.

[21] Davudian Talab A, Farzanegan Z, Mahmoudi F. Effects of occupational exposure on blood cells of radiographers working in diagnostic radiology department of Khuzestan Province. Iran J Med Phys. 2018;15(2):66-70.

[22] Park S, Seo S, Lee D, Park S, Jin YW. A cohort study of Korean radiation workers: Baseline characteristics of participants. Int J Environ Res Public Health. 2020;17(7):2328.

[23] Heidari S, Taheri M, Ravan AP, Moghimbeigi A, Mojiri M, Naderi-Khojastehfar Y, et al. Assessment of some immunological and hematological factors among radiation workers. J Biol Todays World. 2016;5(7):113-119.

[24] Shu X, Wang J, Zeng H, Shao L. Progression of Notch signaling regulation of B cells under radiation exposure. Front Immunol. 2024;15:1339977.

[25] O'Brien G, Cruz-Garcia L, Majewski M, Grepl J, Abend M, Port M, et al. FDXR is a biomarker of radiation exposure in vivo. Sci Rep. 2018;8(1):1-14.