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BIOCHEMICAL STUDY OF THE EFFECTS OF LOW EXPOSURE IONIZING RADIATION DOSES ON THE OPERATORS OF ALTUWAITHA SITE

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Abstract:

Concerns have arisen about the effects of increased exposure to low ionizing radiation and how it impacts physiological processes. As a result, a study was conducted to investigate the impact of radiation exposure on workers at AL Tuwaitha nuclear research center site, specifically on their lipid profile, liver and kidney function. Workers at the nuclear test site are vulnerable to both internal and external radiation, making long-term exposure particularly concerning. In order to assess the effects of radiation, 100 adult subjects between the ages of 22-60 working at the site were subjected to biochemical test analysis, in addition to a control group of 50 adult subjects aged 24-60 residing outside the nuclear center. This study was conducted from September to December in 2022. At the Al-Tuwaitha site, the Directorate of Central Laboratories conducted the study. Using a disposable 5 mL syringe, human peripheral blood was collected from each participant via venipuncture. After withdrawing the blood, it was put into a centrifuge at 3000 rpm for ten minutes. The specimen was then placed in an Eppendorf tube. These samples were stored in a freezer at a constant -20 degrees Celsius. Then put it to use.

Liver function tests were conducted and compared to those of the control group, with no significant difference found. The results found that low ionizing radiation doses had not changed liver function tests. The statistical results obtained to study the effect of gender and age on liver function did not find any relationship between gender and age and were not associated with liver function. Furthermore, no association was discovered between low cumulative levels of radiation and liver injury. The reasons may be that there is no direct exposure to radiation and that there is a simple exposure that is treated by the liver.

The kidney function tests, namely urea, creatinine, and uric acid, showed no significant difference ($P>0.05$).The separation by gender demonstrates that the mean urea and creatinine were not significant ($P> 0.05$) in the male workers and the control group compared to the females in this group. However, a statistical analysis concluded that the variance in uric acid was significant ($P<0.05$) for exposed men compared to women. This finding was likely due to the higher levels of uric acid in men, who predominantly work in nuclear facilities. Uric acid is an indicator of antioxidants, so its increase denotes a slight influence of low-dose ionizing radiation in that workplace.

An analysis of the lipid profile of cholesterol and triglycerides (TG) show a significant difference ($P<0.05$), that TG increases significantly ($P<0.05$) and that Cholesterol shows a non-significant difference ($P > 0.05$) in comparison with the control. The separation by gender demonstrates that the mean cholesterol and triglycerides were not significant ($P> 0.05$) in the male workers and the control group compared to the females in this group. Possible reasons for the increased fat levels are due to medical conditions, diet, or environmental exposure. The statistical examination of cholesterol and triglyceride in various age groups in different locations showed no significant difference ($P>0.05$) among the cholesterol age groups but a notable increase in triglycerides among the 50–60-year-old age group. The probable cause is due to a lack of bodily efficiency and exposure to environmental factors such as oxidative stress damage, which leads to lipid peroxidation.

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INTRODUCTION

Several genotoxic agents within occupational and environmental settings exhibit potential for harmful biological outcomes such as fatality or carcinogenesis, Among genotoxic agents, ionizing radiation (IR) has been used for diagnostic and therapeutic medical purposes (Havaki *et al.*, 2015). Although radiation levels experienced by medical personnel remain low, those ionizing doses that accumulate throughout several years on the job can hold carcinogenic properties (Rajaraman *et al.*, 2016). IR exposure can generate cellular lesions either through direct influence or via oxidative stress from radiolysis, which intern can lead to the detriment of crucial biomolecules like DNA, proteins, and lipids (Nikitaki *et al.*, 2015).

The production of erythropoietin, filtration of metabolites and electrolytes, and regulation of blood pressure are all crucial tasks the kidneys perform (Baradaran-Ghahfarokhi, 2012). Radiation can have detrimental effects on multiple organs, but when it comes to severe harm, the kidney is likely the most sensitive of abdominal organs (Robbins and Zhao, 2004; Fuma *et al.*, 2016). It seems tubular epithelial cells are particularly vulnerable to radiation compared to epithelial cells in other tissues.

Radiation nephropathy, which reduces renal function and causes structural changes in glomerular and tubular cells, is a common side effect of kidney irradiation (Romanenko *et al.*, 2012; Ilhan *et al.*, 2016). Renal injury can also occur as a result of external IR exposure or cancer radiotherapy (El-Gazzar *et al.*, 2016). In addition to these radiation-related causes, nephrotoxicity has been linked to certain chemotherapy agents, as evidenced by changes in glomerular filtration rate, creatinine clearance, blood and urine urea nitrogen levels, and other negative effects (Nephrotoxicity), studies can also show cystic changes, interstitial nephritis, urethral damage, or colitis resulting from chemotherapy (Nego *et al*; 2015).

Liver function must be taken into account as the liver is easily affected by radiation. The monitoring of liver disease progress is aided by enzyme level tracking. Liver cells release certain enzymes into the bloodstream upon infection, contributing to liver chemistry changes. Bloodstream chemicals may indicate potential liver issues due to changes in their levels. Measurable chemical levels are a key part in determining any issue with the liver, which is why a liver function test (LFT) is necessary (Dooley *et al.*, 2018). There are more sensitive biochemical tests that can pick up radiation exposure. For example, Aspartate amino transaminase (AST) or Glutamic Oxaloacetate Transaminase (GOT) are enzymes typically located in liver cells, but they leak out and travel through the bloodstream when the liver cells are damaged. In comparison, the Alanine amino transferees (ALT) or Glutamic Pyruvic Transaminase (GPT) enzyme is a more specific sign of liver inflammation. It's important to note that GOT is also present in various organs such as the heart and skeletal muscle. One enzyme that can be found mostly in the liver and kidney is Alanine aminotransferase (ALT). Liver disease can be screened for and monitored by testing for increased ALT levels. ALP, an enzyme present in bloodstreams, primarily originates from the liver. Assessing ALP levels can indicate the liver and gallbladder's efficacy or highlight bone difficulties. Ismail and Abdulla (2021) and Koram *et al.* (2007) have mentioned this. The liver is a very important organ for metabolism because it stores glycogen, breaks down drugs, makes cholesterol and steroid hormones, and makes important serum proteins like coagulation factors and redox that keep the body from being too sensitive to radiation, Due to the effect of ionizing radiation on liver function and enzymes which will inevitably cause changes in liver cell metabolism (Li, T. *et al.*, 2021).

Playing a critical role in biological systems, lipids are necessary for the formation of biological membranes, providing a hydrophobic medium for membrane proteins to function and interact with each other. By undergoing enzyme reactions, they also produce second messengers. Additionally, the lipid bilayer structure allows cells to be somewhat self-sufficient, independent of external influences. In terms of radiation, a number of studies have analyzed the connection between serum/plasma lipid levels and radiation, revealing that ionizing radiation can disrupt phospholipid metabolism, resulting in an increase of phosphatidylethanolamine and phosphatidylserine. However, only a few limited studies have investigated ionizing radiation's potential effect on lipid or metabolite levels in the bloodstream. Finally, it is worth noting that lipid membranes treated with ionizing radiation typically undergo lipid degradation (Laiakis *et al.*, 2014; Yang and Han, 2016).

When biological tissues are exposed to radiation through the radiolysis of water, a wide range of free radicals are made. subsequently resulting in oxidative harm to biological molecules. This study has been conducted to investigate the toxic effects of exposure to radiation on workers at the Al Tuwatha site. This included the effect on biochemical parameters (urea, uric acid, GOT, GPT,ALP, creatinine, triglycerides, and cholesterol)

MATERIALS AND METHODS

Study Population

Engaged as the exposed group, there were 100 full-time Al-Tuwaitha site workers out of the total of 150 participants in the study. The remaining 50 healthy volunteers served as non-exposed controls. Among the exposed workers, 66 participants were male while 34 were female. On the other hand, the control population had 30 male and 20 female participants who were selected based on their lack of radiation exposure history for diagnostic or therapeutic purposes. Included in the questionnaire that each participant was required to fill out were their medical history, sociodemographic information, and any inherited genetic disorders, chronic illnesses, or recent medical treatments, radiography, vaccinations, severe infections, or viral diseases. From the Al-Tuwaitha site, blood serum samples were gathered and subjected to testing at the Directorate of Central Laboratories located at the same site. This had been a three-month process (September to December 2022) where verbal consent was acquired from the workers and healthy individuals selected for the experiment. The purpose and goal of the research were discussed to reassure the participants that their information would solely be utilized for research purposes and privacy maintained. 5 ml of blood from each participant was drawn, after which, it was carefully placed in a centrifuge that was set at 3000 rpm for ten minutes. Following the centrifugation process, the serum was cautiously segregated and then transferred into the Eppendorf tube. Examining liver, kidney functions, and lipid profile required 50 control samples obtained from healthy individuals. To preserve the samples, they were maintained at a constant -20°C temperature. Additionally, 100 worker samples were gathered in a similar manner for analysis.

Examination of Biochemical parameters

The Randox company in England made a test kit that was used to measure ALT and AST activity in serum. The colorimetric method of Reitman and Frankel was employed for assessing ALP activity through linear interaction at the France company (Kind and King, 1954; Belfield and Goldberg, 1971). For analyzing uric acid levels, the Biosystem company' reagent kits were implemented, following instructions provided by Fossati *et al.* (1980). Serum urea levels were calculated by using a Biosystems Company kit, as stated in Searcy et al. (1967). Our measurement of serum creatine levels involved a spinreact kit from Bartels and Wüthrich (1994). Meanwhile, the determination of serum cholesterol was conducted with a Biolabo kit from a French company, as detailed in (Allain et al. 1974; Wu, 2006). Lastly, we used a Biolabo kit from a French company cited by (Tietz, 1999). measure serum triglycerides.

RESULTS AND DISSCATION

Table 1 displays the impact of being exposed to non-ionizing radiation on a variety of stress-related factors found in the blood.

Table 1. Effect of Age, Gender and Site on the Mean ± STDEV value for Uric acid, Urea and Creatinine

Site	Uric acid	Urea	Creatinine
Control	A 5.476 ± 1.312	A 30.44 ± 5.107	A 0.728 ± 0.140
Workers	A 5.299 ± 1.306	A 32.02 ± 4.852	A 0.753 ± 0.122
$Lsd_{0.05}$	0.448	1.667	0.043
Gender			
Male	A 5.520 ± 1.197	A 31.17 ± 5.216	A 0.736 ± 0.130
Female	B 5.078 ± 1.467	A 32.05 ± 4.580	A 0.760 ± 0.126
$Lsd_{0.05}$	0.438	1.630	0.425
Age			
20 – 29	A 5.596 ± 1.271	AB 30.14 ± 5.676	A 0.709 ± 0.134
30 – 39	A 5.404 ± 1.239	B 29.71 ± 5.069	A 0.704 ± 0.132
40 – 49	A 5.403 ± 1.385	AB 32.19 ± 4.755	A 0.765 ± 0.126
50 - 60	A 5.105 ± 1.287	A 32.46 ± 4.568	A 0.762 ± 0.121
$Lsd_{0.05}$	0.644	2.397	0.624

Similar latter in a column mean there is no significant difference

The kidney function test has been used on serum obtained from 100 individuals in Al-Tuwaitha then in comparison to 50 individuals control living in Baghdad from the outside Al- Tuwaitha nuclear site. Three were studied by using the uric acid, urea, and creatinine. Table (1) shows uric acid values (Mean± SD) were non-significant in Al-Tuwaitha workers 5.30 ± 1.32 when compared with control group 5.48 ± 1.30. The urea (Mean± SD) shows nonsignificant in all expose groups were 32.02 ± 4.852 and control groups 30.44 ± 5.107. The large majority of biomonitoring studies published consist of males and females. The statistical analysis in

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the study population is routinely performed to evaluate any gender differences Also, Table (1) shows that the comparison between gender uric acid, urea, and creatinine frequencies (Mean ± SD) of the studied samples and control group. The mean urea and creatinine levels in male workers were not significantly different (P>0.05) compared to the female control group. However, a statistical analysis revealed significant difference (P<0.05) between male and female uric acid levels. Surprisingly, the exposed group displayed higher uric acid levels in males than females. This particular gender disparity could be attributed to the fact that men make up the majority of workers at nuclear sites, and as uric acid is a key antioxidant indicator, its increase could suggest a slight effect of low-dose ionizing radiation at the site.

In the analytical provided by Table (1), the levels of uric acid, urea, and creatinine were compared among four age groups: 20-29, 30-39, 40-49, and 50-60 years. Surprisingly, there were no significant differences (P > 0.05) in the kidney function tests between the ages. Biochemistry tests measure chemical compounds that break down during metabolism and were implemented to determine inflammation in the kidneys or liver, control disease progression, assess chemotherapy side effects, and determine exposure to environmental pollutants such as ionizing radiation. Our results, which fell within the normal reference range, showed that the mean levels of uric acid, urea, and creatinine were satisfactory for the Al-Tuwaitha workers tested. Additionally, a kidney function test revealed the serum creatinine level to be more sensitive than blood urea. The site AL Tuwaitha did not show a significant disparity in creatinine levels among the workers exposed, which diverges from other research on kidney dysfunction being the main cause of creatinine elevation. Chauhan *et al.*'s study from 2016 concurs with the current findings, noting that creatinine levels remained within the normal reference range during various chemotherapy courses. Devi *et al.* (2015), Have indicated that blood urea can be indicative of kidney defects. Urea is the principle end product of protein catabolism. Meanwhile, uric acid forms as a result of the catabolism of tissue nucleic acid: purine base metabolism (Martin and Okolie, 2012). The possible causes for the rise in uric acid concentration are the breakdown of purines or a surge in uric acid levels due to overproduction or insufficient excretion (Reddy and Monigari, 2015). Creatinine is the end product of the nitrogenous non-protein blood constituents. It appears that serum levels are directly related to total bodily muscle mass, and it is excreted by the kidneys more efficiently than urea and uric acid. (Sharma and Singh, 2014) Significant quantities of creatinine are linked to abnormal renal function. This study non aggrement with Azizi *et al.* (2017), who confirmed that exposure to mobile phone base stations elevated levels of urea, uric acid, and creatinine in the blood. and This study non aggrement with Mohamed and Sherif (2013), who observed that changes in liver enzyme activity and renal function parameters might be indicative of damage to the liver and kidneys. It has been suggested that oxidative stress causes organ harm after irradiation.

Table 2. Effect of Age , Gender and Site on the Mean ± STDEV value for ALP GOT GPT

Site	**ALP**	**GOT**	**GPT**
Control	A 43.40±14.76	A 21.96±6.12	A 18.16±5.75
workers	A 41.42±15.11	A 22.28±5.63	A 17.93±5.41
$Lsd_{0.05}$	5.171	1.936	1.871
Gender			
Male	A 41.34±14.62	A 22.74±5.89	A 18.55±5.73
Female	A 43.36±15.62	A 21.20±5.49	A 17.07±5.01
$Lsd_{0.05}$	5.058	1.894	1.831
Age			
20 – 29	A 41.77±16.52	B 19.59±4.92	A 15.96±5.33
30 – 39	A 39.36±14.10	AB 20.96±6.93	A 17.86±6.69
40 – 49	A 42.83±12.52	A 23.37±5.97	A 18.84±5.52
50 – 60	A 43.05±15.65	A 22.60±4.36	A 17.92±4.35
$Lsd_{0.05}$	7.435	2.784	2.691

Similar latter in a column mean there is no significant difference

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Table 2 shows Glutamic Oxaloacetate Transaminase (GOT) enzyme values (mean ± SD) were non-significant in all workers at the Al-Tuwaitha site, at 22.28±5.63 when compared with the control group 21.96±6.12. Glutamic Pyruvic Transaminase (GPT) (mean ± SD) enzyme shows nonsignificant differences in all exposure groups: were 17.93±5.41 and control groups: 18.16±5.75. Alkaline phosphatase enzymes values were non-significant (P> 0.05) in workers in Al-Tuwaitha site were 41.42±15.11 when compared with control group 43.40±14.76. the normal reference range of GOT (8–41) IU/L and GPT (7–55) IU/L, while the normal reference range of the alkaline phosphatase enzyme is 32–92 IU/L.

Table 2 shows the results of the effect of gender on the level of liver function test (mean ± SD) in the human serum workers in the Al-Tuwaitha area and the control group. The gender separation shows that the GOT enzyme means were not significant (P> 0.05) in the males of the studied samples and controls as compared with the females in this group. Regarding the GPT enzyme, statistical analysis has shown that no significant difference (P > 0.05) existed between men and women in the studied samples and control groups. The alkaline phosphate enzyme (ALP) level shows no significant difference (P > 0.05) between males and females in the studied samples, as compared with females in this group. Table (2) shows a statistical analysis of the GOT enzyme in different age groups. In all locations In terms of ages, donors have been divided into four groups: (22-29),(30-39),(40-49), and (50-60). It has been found that there is no significant difference (P > 0.05) between the age groups in all parameters of liver function (GOT,GPT, and ALP).

Changes in radiation dosage series may lead to significant harm in the liver, affecting both structure and function of cells as well as causing tissue damage and death, as has been discovered by Tanaka *et al.* (2013). Protein building blocks are reorganized by the liver enzyme GPT. High levels of the ALP enzyme show problems with the liver, as noted by Pratt and Kaplan (2000). Serum measurements of GPT and GOT serve as telling signs of hepatic toxicity, swiftly increasing when the liver is impacted by causes such as radiation, cirrhosis, or hepatitis. Transaminases play a crucial role in protein and amino acid metabolism, existing in nearly all tissues and being released into the bloodstream in response to tissue damage or disease (Pratt and Kaplan, 2000). A rise in liver enzyme activity, specifically GPT and GOT, has been observed by certain experts (Makhlouf and Makhlouf, 2012). Furthermore, previous research has linked radiation exposure with liver cancer, prompting this investigation into the monitoring of liver function test parameters (LFT) in such cases. A different diagnosis of liver cancer has been reported in various studies of radiation-exposure workers due to the liver being a radiation-sensitive organ. Ionizing radiation induces oxidative stress, which causes several biological effects, with the extent varying based on exposure doses, as noted by Pernot (2012).

According to these findings, liver function tests were apparently unaffected by low doses of ionizing radiation. Perhaps a lack of direct exposure to radiation or the liver's ability to handle simple exposure is to blame, but Interestingly enough, these results line up with previous studies (Finteil *et al.*, 2019; Shahid and Masood, 2018) that also saw no impact on the liver enzymes of radiation field workers subjected to low levels of ionizing radiation. In the endeavor to explore how gender impacts liver function, the statistical findings were not in any way notable (P>0.05) between men and women involved. Thus, there seems to be no connection between gender and liver function. Additionally, we found no association between liver injury and a low ionic dose seen cumulatively throughout the study. It is noteworthy that our present research, in concurrence with Sun *et al.* (2018), validates these results. Liver function and how gender and age affect it were analyzed statistically. The investigation showed no apparent link between liver damage and gender or age. The exploration on low ionic radiation dose and liver injury did not reveal any correlation, which is consistent with the findings of Sun *et al.* in 2018.

Table 3. Effect of Age, Gender and Site on the Mean ± STDEV value for TG, Cholesterol.

Site	**TG**	**Cholesterol**
Control	B 105.74±21.66	A 169.46±25.84
Workers	A 134.79±27.35	A 166.83±19.82
$Lsd_{0.05}$	14.54	13.23
Gender		
Male	A 125.42±26.07	A 169.24±21.76
Female	A 124.56±17.20	A 165.06±24.91
$Lsd_{0.05}$	14.22	12.94

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Age		
20 – 29	B 108.86±25.01	A 155.82±21.99
30 – 39	B 118.68±24.67	A 169.89±27.51
40 – 49	B 122.57±28.09	A 173.46±26.44
50 – 60	A 143.95±31.66	A 163.32±19.68
$Lsd_{0.05}$	20.91	19.02

Similar latter in a column mean there is no significant difference

The levels of cholesterol (mg/dl) and triglycerides (mg/dl) differed between the exposed AL Tuwatha site workers and the control group, as seen in Table 3. Specifically, there was a non-significant difference (P>0.05) in cholesterol levels between the two groups, with mean levels of 166.83±19.82 and 169.46±25.84, respectively. However, triglyceride levels showed a significant increase in the exposed workers, with a mean of 134.79±27.35 compared to 105.74±21.66 in the control group. Interestingly, the effect of gender on cholesterol and triglyceride levels was also examined. The results of Table 3 revealed that the means of these biomarkers were not significantly different (P>0.05) between males in the studied and control groups, nor were they significantly different from females in these groups. Within all locations, Table 3 displays an analysis of cholesterol and triglyceride levels among varying age groups. The donors were split into four groups based on age: (22-29), (30-39), (40-49), and (50-60). Surprisingly, no significant difference (P > 0.05) in cholesterol was found between the age groups. However, we did observe a noteworthy increase in triglyceride levels within the 50–60 age group. It's possible that this is due to a decreased efficiency in bodily function, along with exposure to external factors such as oxidative stress-induced lipid damage.

Organic compounds known as lipids play a vital role in proper metabolism and the proper functioning of an organism. Any interruptions in the anabolic or catabolic processes of lipoproteins can result in pathological processes within cells. The metabolic syndrome, consisting of obesity and overweight, can lead to lipid and lipoprotein metabolism disorders that are likely to increase the chances of cancer and affect cancer patient prognoses (Hashmi *et al*., 2015). The impact of radiation exposure on lipid profile levels was insignificant, except for triglyceride. This could possibly be due to lifestyle or dietary differences. However, research has suggested that radiation treatment could lower lipid serum levels,and these outcomes have been verified and confirmed by (Wolny-Rokicka *et al*., 2019) Our study found the result not aggrement with Jackson *et al*. (2010), who noticed that laser therapy is effective in reducing both cholesterol and triglyceride levels.

CONCLUSION

The liver and kidney function tests, as well as the lipid profile parameters, were left unaffected by the low doses of ionizing radiation. Biochemistry test results showed no changes. There were no significant differences compared with the control, and we did not find any relationship between gender and age that was not associated with the biochemistry test. Except uric acid test increasing in the uric acid level in males than in females in the exposed group. Perhaps the reason is due to the higher uric acid in men than women because the workers who enter the nuclear sites are mostly men, and since uric acid is considered a good indicator of antioxidants, its increase indicates a slight effect of low-dose ionizing radiation at that site. The result of lipid profile levels was not influenced by exposure to radiation, except for triglyceride. The reason may be due to a diet or lifestyle difference. However, we noticed a significant increase in triglycerides among the age groups (50–60). Perhaps the reason is due to the lack of vital efficiency in the body as well as exposure to other environmental factors, such as oxidative stress damage that leads to lipid peroxidation.

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