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Changes in some hematological parameters in radiology unit workers during the Covid-19 pandemic: Retrospective study

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► ***Short report***

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ABSTRACT

Background*:** The purpose of this study is to retrospectively compare annual changes (between 2019 and 2022 years) in selected hematological parameters in radiology workers during the COVİD-19 pandemic. ***Material and Methods*:** A total of sixteen radiology unit workers, seven male and nine female, aged 18-40 years, working in Ataturk University Faculty of Medicine, Department of Radiology in 2019-2022, were included in this retrospective study. The annual changes (between 2019-2022) of the participants in selected hematological parameters such as white blood cell (WBC), hemoglobin (HGB) and red blood cell (RBC) during the COVID-19 pandemic were compared. ***Results*:** There was a statistically significant difference when comparing the annual changes in WBC value during the COVID-19 pandemic ($F(3, 36)=3.141$, $p=.037$, $\eta p2= .207$). It was observed that WBC decreased significantly in 2022 compared to 2021 ($p<0.05$). Moreover, a statistically significant difference was found in the comparison of the annual changes in the RBC value during the COVID-19 pandemic ($F(3, 36)=25.370$, $p=.000$, $\eta p2= .712$). It was found that RBC diminished significantly in 2020, 2021, and 2022 compared to 2019. Additionally, a statistically significant difference was detected when comparing the annual changes in HGB value during the COVID-19 pandemic ($F(3, 36)=26.794$, $p=.000$, $\eta p2= .691$). It was determined that HGB decreased significantly in 2022 compared to 2020 and 2022 compared to 2021 ($p<0.05$). ***Conclusion: It is known that radiology workers are exposed to more and more prolonged radiation due to the increase in patient density and the length of their working hours during the COVID-19 pandemic period. Radiation also has harmful acute and chronic effects on human health. In this process, it is seen that exposure to both COVID-19 and Ionizing Radiation (IR) increases the sensitivity of hematological parameters.

INTRODUCTION

There is a direct relationship between the work done in the working environment and the health of the individual. Functional areas contain many health and safety hazards. This includes work accidents and occupational diseases that can directly affect health [1]. Throughout life, individuals are exposed to radiation, albeit in small amounts, almost daily. The adverse effects of this small amount of radiation can be tolerated by the organism in some way. Individuals working in radiological diagnosis and treatment units such as Nuclear Medicine and Radiology are more exposed to IR [2].

IR means radiation that can form charged ions when it hits matter. The realization that ionization can occur in substances, humans, and all living things. When exposed to IR, the energy generated by the triggering of the radiation causes the stimulation of hydroxyl radicals and DNA chain breaks. This damage can result in cell death, immune response deficiencies, and anemia [3]. According to the radiobiology master rule, the most sensitive cells are erythroblasts (erythrocyte mother cells). Although leukocytes transform into differentiated cells when administered to the blood, they are susceptible to IR [4, 5].

Blood is composed of a liquid matrix (plasma) that makes it a liquid, as well as cellular elements, namely Erythrocytes (RBC), Leukocytes (WBC) and Platelets (PLT). Since the cellular elements of blood are short-lived, they are constantly renewed [6, 7]. Therefore, HGB concentration, one of the essential components of complete blood count, is a value used to evaluate patients' anemic and polycythemic status [8]. Leukocytes are a heterogeneous group of nucleated cells that can circulate at least once in their lifetime. Average concentrations in the blood range from 4000 to 10,000 per µl. They have phagocytosis abilities and thus play a distinctly important role in immunity [9].

Exposure to IR is known to have lethal effects on blood cells [10, 11]. Leukocytes and erythrocytes are constantly renewed cells, so they are susceptible. The reduction in peripheral blood cell counts recorded within the first 48 hours of radiation exposure serves as a marker for the severity of exposure and

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treatment and prognosis [10].

COVID-19 disease was first reported in December 2019 as a pneumonia case of unknown etiology in Wuhan, China's Hubei province [12]. This disease spread rapidly too many countries, causing the death of more than 4000 people as of March 2020. Since then, COVID-19 has been officially declared a pandemic by the World Health Organization (WHO) [13, 14]. COVID-19 can be found in domestic and wild animals such as bats, humans, cats, dogs, pigs, rodents, and poultry. Although mainly Alpha and Beta coronaviruses are found in bats, they can also infect other species, such as humans, cats and dogs [15]. The main symptoms of COVID-19 are fever, fatigue, and cough. While COVID-19 usually causes colds and mild upper respiratory tract infections in immunocompromised people, it can occur as lower respiratory tract infections in older people or people with weakened immune systems [16].

In the literature review, no study was found in which hematological parameters were evaluated longitudinally during the COVID-19 pandemic in radiology unit workers. The purpose of this study is to retrospectively compare annual changes (between 2019 and 2022 years) in selected hematological parameters in radiology workers during the COVID-19 pandemic.

MATERIALS AND METHODS

Design of the study

A total of 16 radiology unit workers, seven male and nine female, aged 18-40 years, working in Ataturk University Faculty of Medicine, Department of Radiology in 2019-2022, participated in this retrospective study voluntarily. The blood parameters taken once a year as specified by the radiation safety regulations were used. The annual average doses of employees in the radiology department are given in table 1.

Table 1. Distribution of the annual effective dose (mSv) to radiation workers in the radiology department conventional, fluoroscopy, and mammography X-ray).

Occupational category	Radiation workers	Annual dose (mSv)
Diagnostic Radiology Dept.	Radiologist	0,59 (0,04-1,15)
	Technician	0.58 (0.51-0.65)
	Nurse	0.72 (0.61-0.82)
	Medical Physicist	0.4 (0.35-0.44)

Our file criteria to be included in the study are as follows:

1. To be between the ages of 18-40.
2. Working at Atatürk University Health Research and Application Center Radiology Unit.
3. To have given a continuous blood test in occupational medicine between 2019-2022.

The sample of the research

In order for the 15% difference in sensitivity of 0.80-0.95 to be meaningful in the screening of selected hematological parameters during the COVID-19 pandemic (between 2019-2022) in radiology workers, the participation of at least 15 healthy individuals in the study at 80% power and 95% confidence level was determined through the NCSS/PASS program. According to the calculated power analysis, our study was carried out on individuals aged 18 and 40 working in 16 radiation units that met our criteria. In addition, the annual changes (between 2019-2022 years) of the participants in selected hematological parameters such as WBC, RBC and HGB during the COVID-19 pandemic were compared. These parameters were scanned from the file using a retrospective research design. The occupational safety specialist in the study team carried out the screening.

Ethical statement

Before the study, permission was obtained from the University Clinical Research Ethics Committee at Ataturk University (Number: B.30.2.ATA.0.01.00/313). Individuals who agreed to participate in the study were asked to read and sign the Informed Consent Form conducted by the Declaration of Helsinki Principles.

Statistical analysis

Data were expressed as mean±standard deviation (SD) in bar graphs, and individual variations were demonstrated in scatter plot graphs. The results of the Shapiro-Wilk test showed that the data distribution was normal ($p>0.05$).

Moreover, variances were found to be homogeneous for all hematological parameters (WBC, RBC and HGB). Finally, sphericity was analyzed by Mauchly's test. According to this test, sphericity assumed values were taken into account for three parameters ($p>0.05$).

Therefore, Repeated Measures ANOVA was used to compare annual changes (between 2019-2022 years) in selected hematological parameters during the COVID-19 pandemic. The Bonferroni test was used to make the pairwise differences. The significance level was interpreted according to $p<0.05$.

RESULTS

In the study, annual doses were well below the established 50-mSv occupational dose limits for adults in the United States [17].

Figure 1A shows the annual variations in the total mean score of the WBC parameter (mean±standard deviation) in bar charts. Figure 1B shows the annual comparison of the individual interpretations of the RBC parameter in scatter plot graphs. According to the figures above, the Repeated Measures ANOVA test

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showed a statistically significant difference when comparing the annual changes in WBC value during the COVID-19 pandemic ($F_{(3, 36)}$=3.141, p=.037, ηp2= .207). According to Bonferroni test results, it was observed that WBC decreased significantly in 2022 compared to 2021 (p<0.05).

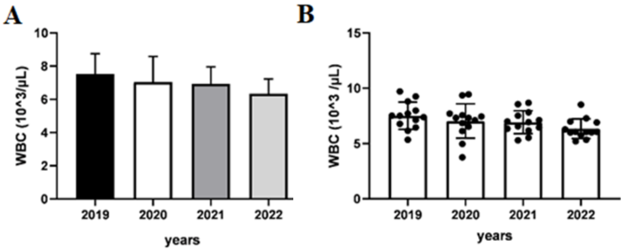

Figure 1. Comparison of total and individual annual changes in WBC parameters during the COVID-19 pandemic.

Figure 2A shows the annual changes in the total mean score of the RBC parameter (mean±standard deviation) in bar charts, and figure 2B shows the annual comparison of the individual variations of the RBC parameter in scatter plot graphs. According to the figures above, a statistically significant difference was found in comparing the annual changes in the RBC value during the COVID-19 pandemic ($F_{(3, 36)}$ =25.370, p=.000, η_p^2= .712). Furthermore, according to the Bonferroni test results, It was observed that RBC decreased significantly in 2020, 2021, and 2022 compared to 2019. In addition, it was observed that RBC significantly reduced in 2022 compared to 2020 and 2022 compared to 2021 (p<0.05).

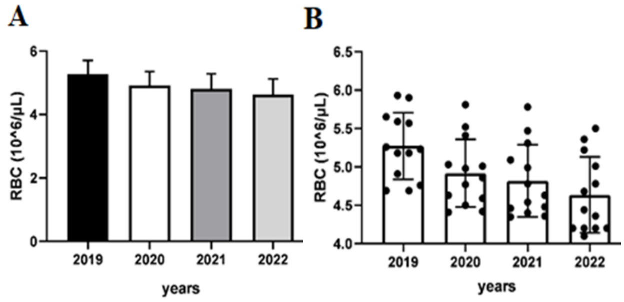

Figure 2. Comparison of total and individual annual changes in RBC parameters during the COVID-19 pandemic.

Figure 3A shows the annual changes in the total mean score of the HGB parameter (mean±standard deviation) in bar charts, and figure 3B shows the annual comparison of the individual variations of the HGB parameter in scatter plot graphs. According to the figures above, a statistically significant difference was found when comparing the annual changes in HGB value during the COVID-19 pandemic ($F_{(3, 36)}$ =26.794, p=.000, η_p^2= .691). According to the Bonferroni test results, It was determined that HGB decreased in 2021 and 2022 compared to 2019. In addition, it was observed that HGB significantly reduced in 2022 compared to 2020 and 2022 compared to 2021 (p<0.05).

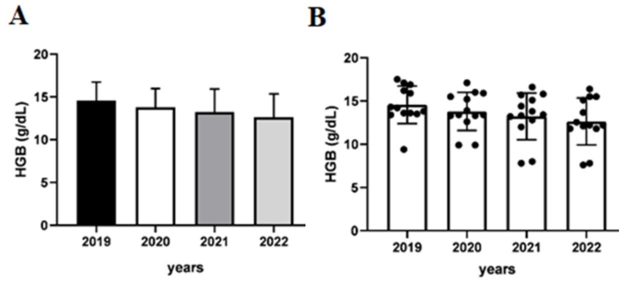

Figure 3. Comparison of total and individual annual changes in HGB parameters during the COVID-19 pandemic.

DISCUSSION

It is a known fact that radiology workers are exposed to more and more prolonged radiation due to the increase in patient density and the length of their working hours during the COVID-19 pandemic period. In this retrospective study, which we conducted as a four-year data file scan, we presented the first evidence indicating that some hematological values of radiology personnel decreased over the years and were adversely affected by radiation during the COVID-19 pandemic.

Although exposure to low doses of IR may not be perceived as significant, in reality, long-term exposure can cause severe changes in the lives of individuals. These changes affect life negatively and cause worse situations with the addition of health problems. Therefore, necessary precautions should be taken regarding radiation safety and occupational health and safety of these people exposed to IR in their work areas, both by themselves and by the institutions they work for [1, 5].

The first cell group affected after radiation exposure is leukocytes. The decrease in leukocytes due to radiation exposure can occur within minutes or hours after exposure. Lymphocytes constitute the most sensitive cell group among leukocytes [5, 18]. In literature, a cohort study associated with the COVID-19 pandemic showed an increase in leukocyte levels but a decrease in lymphocyte levels. In another retrospective study, it was stated that lymphocyte, T cell subgroups, eosinophils and platelet counts decreased significantly, especially in severe/critical and fatal patients [19, 20]. Again, in a retrospective study conducted after COVID-19, it was shown that the neutrophil counts of those with chronic disease had higher values than those without a chronic illness, and those with chronic disease had lower platelet counts than those without a chronic illness [18]. In our study, significant difference when comparing the annual changes of WBC value during the COVID-19 pandemic, and it was observed that WBC decreased significantly in 2022 compared to 2021. The reason for this decrease in WBC levels of radiology workers over the years can be explained by the irregularities in hematological parameters as a result of intense working conditions and exposure to more radiation due to the COVID-19 pandemic.

Erythrocytes are more resistant to radiation than

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other blood cells due to their long life in peripheral blood. Damages become apparent a few weeks after exposure, and healing ranges from six months to a year [5]. Our study found a statistically significant difference in comparing the annual changes in the RBC value during the COVID-19 pandemic. A survey related to COVID-19 reported that patients had lower RBC values in their peripheral blood system but higher lymphocyte, neutrophil, platelet, and HGB values [5]. One of the most critical indicators of oxygen transport capacity in the blood is hemoglobin density. Hemoglobin levels were found to be low in individuals who had COVID-19 infection, especially those who developed complications and were at high risk of death [21, 22].

In addition, it was observed that RBC decreased significantly in 2020, 2021, and 2022 compared to 2019 and decreased substantially in 2022 compared to 2020 and 2021. In another study, it was stated that these hematological differences reduce the half-life of RBC or suppress its production in patients who died due to the COVID-19 pandemic [23, 24]. In addition, studies have suggested that RBC damage may have occurred due to the cell damage formation process due to immune system-mediated mechanisms or COVID-19 with its microangiopathy [25-27].

CONCLUSIONS

This retrospective study presents the first evidence of low RBC, HGB, and WBC values in radiology workers due to exposure to intense radiation and COVID-19 infection.

Limitations of the study

Our study is a single-center, retrospective study conducted on a small population. Deficiencies and accessibility may not have been fully realized since the data is obtained through the system registered in the electronic environment. In addition, since retrospective studies cannot fully control the variables, it is recommended to be supported by multicenter prospective studies.

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Ethical approval: The study was approved by the Atatürk University Faculty of Medicine Clinical Research Ethics Committee. Faculty Ethics Committee with the decision dated 31.03.2022 and numbered: B.30.2.ATA.0.01.00/313.

Data sharing statement: None.

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