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The Effect of Handphone Radiation on Hematology Profiles

Septiana Kurniasari[1*], Muhammad Yunus[1], Nursia Madjid[1], Sartika Rusdin Umar[2], Asmiati Amir[3], Nurul Fuadi[4]
[1]*Physics Study Program, Faculty of Mathematics and Natural Science, Universitas Negeri Gorontalo, Indonesia*
[2]*Science Education Study Program, Faculty of Mathematics and Natural Science, Universitas Negeri Gorontalo, Indonesia*
[3]*Radiology Study Program, Politeknik Kesehatan Muhammadiyah Makassar, Indonesia*
[4]*Physics Department, Faculty of Science and Technology, UIN Alauddin Makassar, Indonesia*

Corresponding Authors E-mail: septiana@ung.ac.id

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Abstract

The use of handphone is increasing, making handphone users have to focus more on the side effects of using handphone on health. Handphone is included in the category of electromagnetic waves. Exposure to electromagnetic fields can affect human health, especially the hematological profile. This type of research is observational research with a descriptive approach. Hemoglobin, erythrocyte, leukocyte and thrombocyte levels were obtained from the results of blood checks in the laboratory. The results showed that exposure to handphone radiation caused a decrease in hemoglobin levels up to 11%, an increase in erythrocyte levels up to 13%, an increase in leukocyte levels up to 14%, and an increase in thrombocyte levels up to 35%.Handphone radiation triggersoxidative stress caused by formation of ROS (Reactive Oxygen Species).

Introduction

Handphone is a communication tool that is widely used by people all over the world. Based on data obtained from survey institutions, the increase in handphone users is very significant every year. In 2016 there were 65.2 million handphone users, 74.9 million in 2017, 83.5 million in 2018, and 92 million in 2019, and this number will continue to grow [1]. The use of handphone is increasing, making handphone users have to focus more on the side effects of using handphone on health. Handphone is included in the category of electromagnetic waves. Exposure to electromagnetic fields can affect human health, including the system of

blood circulation, reproductive system, nervous system, cardiovascular system and endocrine system [2].

Exposure to handphone radiation can cause significant changes in blood pressure, pulse and dizziness. The longer using a handphone, the greater the radiation received by the user, which is characterized by an increasing sensation of dizziness and changes in blood pressure and pulse [3], changes in cell membrane permeability, changes in the composition of blood formation, changes in ion exchange in nerve tissue and changes in cancer rates are closely related to the formation of enzymes [4]. Giving handphone radiation exposure can increase malondialdehyde levels and reduce cholesterol levels in Wistar Albino rats [5]. Exposure to electromagnetic waves affects changes in serum lipid profile levels such as total cholesterol and triglyceride levels [6].

Each hematopoietic cell has a different sensitivity to radiotherapy. Leukocytes are the most radiosensitive blood cells, followed by thrombocytes and then erythrocytes. Erythrocytes are less radiosensitive cells, so their use does not reflect in vivo radiation-induced cell damage. However, due to several reasons, the examination of erythrocytes is still carried out because this examination is suitable for monitoring the effects of radiation. The risk of infection after cancer treatment can be increased by depression in leukocytes, while a decrease in the number of erythrocytes as assessed by hemoglobin levels can reduce the oxygenation ability of cancer patients. Likewise with a decrease in the number of thrombocytes which can trigger bleeding [7].

Hemoglobin, the oxygen-transport metalloprotein in the red blood cells, gives the blood enormous oxygen-carrying capacity; thus oxygen binding to hemoglobin in the lungs and oxygen dissociation in the target tissues are crucial points for oxygen delivery as well as potential targets for intervention [8]. Assessment of hemoglobin (Hb) levels in the blood is a reliable indicator for anemia screening and the deviation of the blood Hb level from its normal value can be used as an indicator for various pathological processes [9]. Gamma radiation affects mainly the globin part, results in unfolding of the protein structure and perturbation in the relative orientation of the transition dipole moments [10]. Gamma-radiation causes morphological malformations of erythrocytes and is harmful to Medaka Fish (*Oryzias latipes*) [11].

Exposure to high-dose ionizing radiation has been associated with both bone marrow and erythrocyte damage, suggesting detrimental effects of ionizing radiation on erythrocyte production and survival. For example, radon (Rn) inhalation in animals leads to chromosomal damage in bone marrow red cell precursors. In animal models, high-energy ionizing radiation emitted from radium can induce hemolysis. Hemoglobin oxidation and denaturation can be caused by high-dose ionizing radiation-induced OH-radicals [*Reactive Oxygen Species* (ROS)]. Finally, lead such as the Rn progeny lead-210 (^{210}Pb) may also adversely affect the bone marrow since lead is a hematotoxin [12].

White blood cells, also called leukocytes, are cells involved in protecting the body against infectious diseases and other foreign invaders. As immune defenders, the leukocytes exhibit excellent tropism to the inflammatory or damaged sites in a self-deformable manner [13]. There was a change in the number of leukocytes after exposure to low doses of X-ray radiation starting from 1 hour after exposure to X-ray radiation and continued to decrease until 24 hours after exposure to X-ray radiation which indicates the process of cell death in

the form of necrosis or apoptosis [14]. Thrombocyte function to maintain the tissue in case of injury. Thrombocyte participate in closing wounds, so that the body does not experience blood shortages and is protected from foreign objects that enter the body [15].

Cervical cancer patients under going radiation therapy using Co-60 experienced a decrease in leukocyte levels from before irradiation by 81.0%, after 5 times irradiation it decreased to 75.0%, and after 10 times irradiation it decreased again to 72.5%. Hemoglobin levels decreased from before irradiation by 50.0%, after 5 times irradiation it decreased to 46.4%, and after 10 times irradiation it decreased to 35.3%. Thrombocyte levels increased before irradiation by 76.2%, after 5 times irradiation it increased to 79.8%, and after 10 times irradiation it became 82.4%. Patients with breast cancer who underwent radiation therapy using Cobalt 60 experienced a decrease in leukocyte levels by 1.03 thousand/µL or 16.07%, whereas after 5 times irradiation with 10 times irradiation it decreased by 0.88 thousand/µL or 16.36%. Erythrocyte levels underwent a change, namely a decrease of 0.33 million/µL or 7.33%, whereas after 5 times irradiation with 10 times irradiation it decreased by 0.27 million/µL or 5.04% [16].

The reference values used to assess the normal levels of hemoglobin, erythrocytes, leukocytes and thrombocytes refer to the reference values used by the Maxima Laboratory (Table 1).

Table 1. Reference Values of Hemoglobin, Erythrocytes, Leukocytes and Thrombocytes (Maxima Laboratory)

Hematology Profiles	Men	Women
Hemoglobin (g/dL)	14.0-17.4	12.3-15.3
Erythrocytes (million/uL)	4.5-5.9	4.5-5.1
Leukocytes (x10^3/uL)	3.8-10.6	3.6-11.0
Thrombocytes (x10^3/uL)	150-440	150-440

This research aims to determine the hematological profile (hemoglobin, erythrocyte, leukocyte and thrombocyte levels) due to handphone radiation in students in the Medical Physics and Biophysics course.

Experimental Method

This type of research is observational research with a descriptive approach. The variables in this study were the levels of hemoglobin, erythrocytes, leukocytes and thrombocytes, which were obtained from the results of blood tests in the Maxima Laboratory. Respondents in this study were 6 students (2 men and 4 women) in the Medical Physics and Biophysics courses. They were M1, M2, W1, W2, W3 and W4 (M for man, W for woman), who used handphone every day for ± 15 hours a day, and the hematology measurements were taken after using the handphone.

The percentage of decreasing in the hematology profile follows the Equation (1):

$$\% = 100 - \left(\frac{x}{a}.100\right) \qquad (1)$$

where :

x = hematology profile value

a = lower limit of reference value

The percentage of increasing in the hematology profile follows the Equation (2):

$$\% = \left(\frac{x}{b}.100\right) - 100 \qquad (2)$$

where :

x = hematology profile value

b = upper limit of reference value

Result and Discussion

Based on the results of research, it is known that exposure to handphone radiation affects a person's hemoglobin, erythrocyte, leukocyte and thrombocyte levels. Table 2 show that handphone radiation exposure can also cause abnormal hemoglobin status, in which case a decrease in hemoglobin levels occurs up to 11%, and Figure 1 are the distribution of hemoglobin value due to handphone radiation exposure, where x axis is each respondent and y axis is hemoglobin value.

Table 2. Distribution of Hemoglobin Status Due To Handphone Radiation Exposure

Hemoglobin Status	n	%
Normal	3	50.00
Abnormal	3	50.00
Total	6	100.00

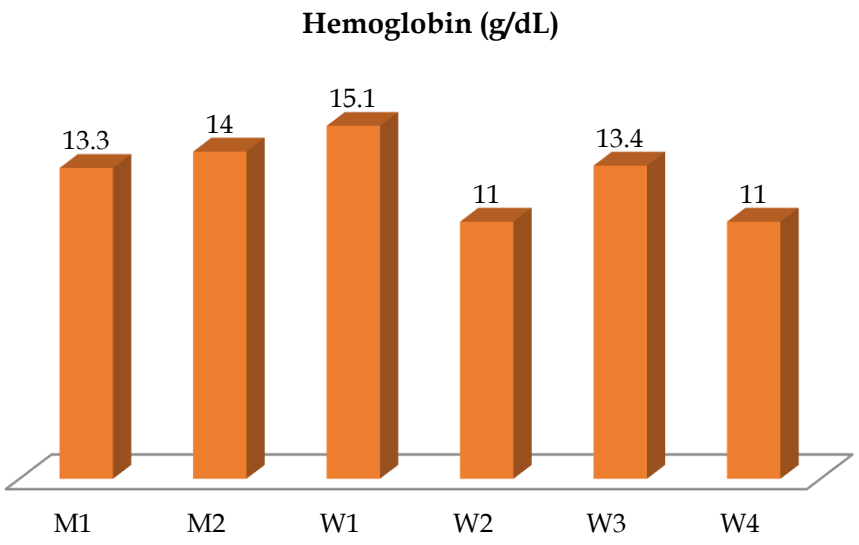

Figure 1. Distribution of Hemoglobin Status Due To Handphone Radiation Exposure

If the level of hemoglobin in the blood decreases, there will be a disturbance in the regulation of the exchange of oxygen with carbon dioxide in the body's tissues, a disturbance in the uptake of oxygen from the lungs which is carried to all the tissues of the body and the inability to dispose of carbon dioxide from the tissues of the body. A decrease in hemoglobin

levels from normal limits can also cause a lack of blood or it is called anemia. Deficiency of hemoglobin is also accompanied by a reduced number of erythrocytes and a hematocrit value below normal limits [17]. Other studies also state that electromagnetic radiation generated from the use of handphone can cause disruption of red blood cells [18]. This was also corroborated from the results of interviews with respondents that they often experience headaches and weakness.

Table 3 show that handphone radiation exposure can also cause abnormal erythrocyte status, in which case an increase in erythrocyte levels occurs up to 13%, and Figure 2 are the distribution of erythrocyte value due to handphone radiation exposure, where x axis is each respondent and y axis is erythrocyte value.

Table 3. Distribution of Erythrocyte Status Due To Handphone Radiation Exposure

Erythrocyte Status	n	%
Normal	3	50.00
Abnormal	3	50.00
Total	6	100.00

This increase in erythrocyte levels can be caused because a person is experiencing stress [19] due to repeated exposure [20]. Other studies also state that the use of handphone can potentially cause stress, sleep disturbances and depressive symptoms in young adults [18].

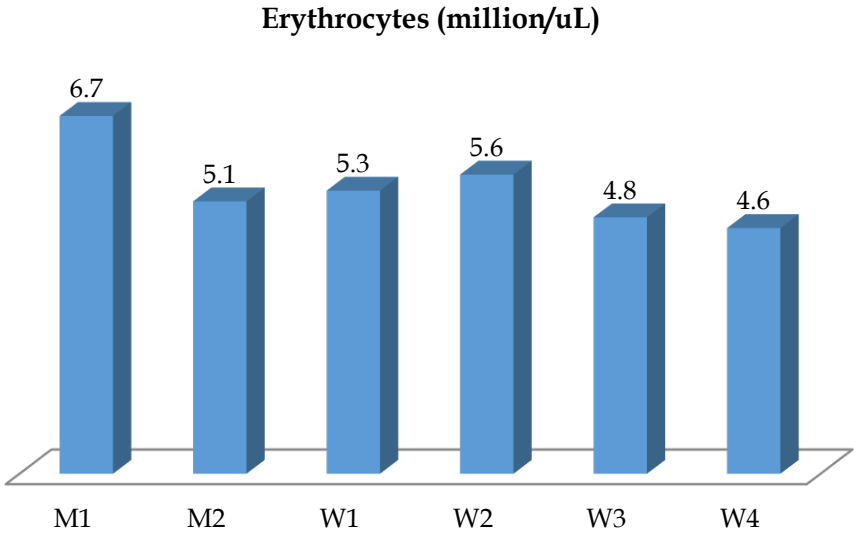

Figure 2. Distribution of Erythrocyte Status Due To Handphone Radiation Exposure

Table 4. Distribution of Leukocyte Status Due To Handphone Radiation Exposure

Leukocyte Status	n	%
Normal	4	66.67
Abnormal	2	33.33
Total	6	100.00

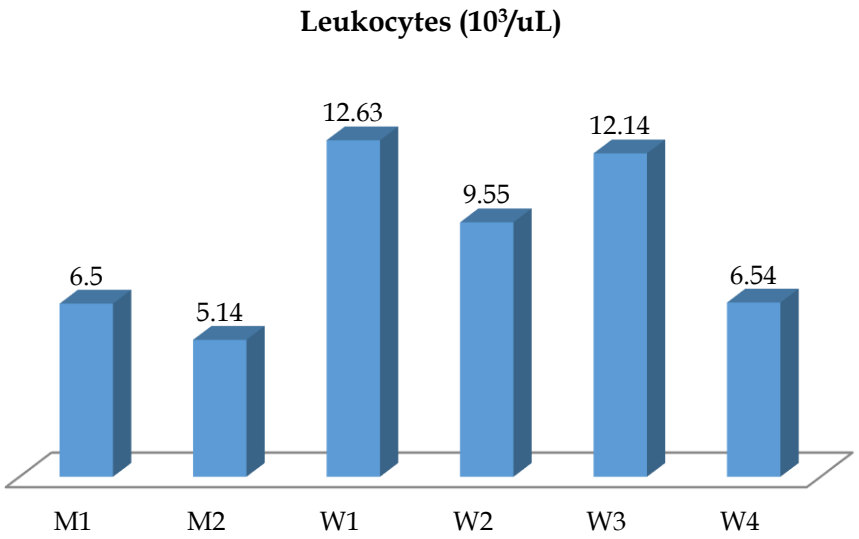

Figure 3. Distribution of Leukocyte Status Due To Handphone Radiation Exposure

Table 4 show that handphone radiation exposure can also cause leukocyte status to become abnormal, in which case there is an increase in leukocyte levelsby up to 14%, and Figure 3 are the distribution of leukocyte value due to handphone radiation exposure, where x axis is each respondent and y axis is leukocyte value.

Successive radiation exposure in mice causes peripheral leukocytes to gradually become radioresistant in vivo [21]. Leukocytes have a very high level of sensitivity to radiation [17]. This increase in leukocyte levels can be caused because someone is experiencing stress. An increase in the number of leukocytes also indicates an infectious process [22] which is caused by the presence of free radicals.

Table 5 show that handphone radiation exposure can also cause abnormal thrombocyte status, in which case there is an increase in thrombocyte levels up to 35%, and Figure 4 are the distribution of thrombocyte value due to handphone radiation exposure, where x axis is each respondent and y axis is thrombocyte value.

Table 5. Distribution of Thrombocyte Status Due To Handphone Radiation Exposure

Thrombocyte Status	n	%
Normal	4	66.67
Abnormal	2	33.33
Total	6	100.00

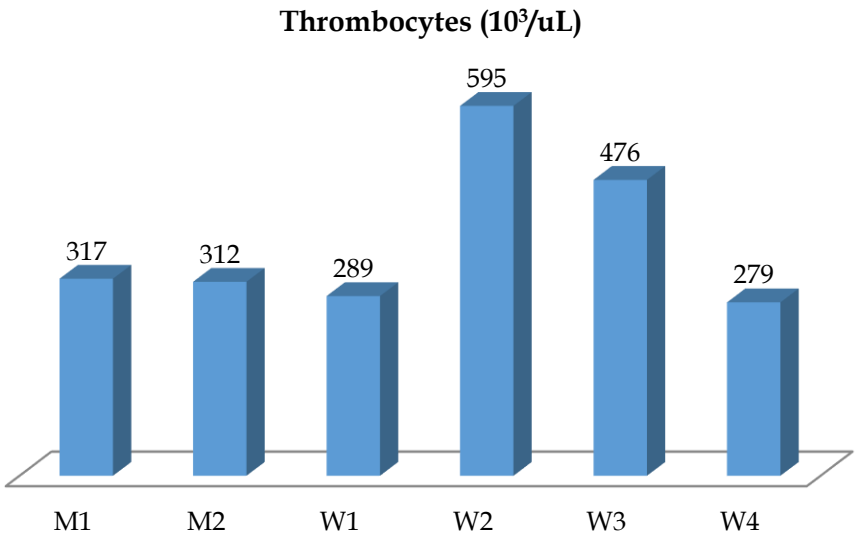

Figure 4. Distribution of Thrombocyte Status Due To Handphone Radiation Exposure

The increase in thrombocyte levels that occurs is due to the emergence of ROS (Reactive Oxygen Species) which results in increased oxidative stress in cells, so that this can trigger the formation of a lot of thrombocyte (thrombogenesis) [23].

Conclusion

Handphone radiation causes a decrease in hemoglobin levels up to 11%, an increase in erythrocyte levels up to 13%, an increase in leukocyte levels up to 14%, and an increase in thrombocyte levels up to 35%. This is due to the formation of ROS (Reactive Oxygen Species) due to handphone radiation exposure, causing oxidative stress.

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