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Title of retracted article: Studying the Amount of Blood Parameters and Liver Enzymes in the Workers of Sanandaj Power Plant

Author(s): Hirash Nadimi, Ali Jalili, Khaled Mohammadi, Vida Nadimi

* Corresponding author. Email: ali130@gmail.com

Journal: Open Journal of Clinical Diagnostics (OJCD)
Year: 2017
Volume: 7
Number: 2
Pages (from - to): 45 - 57
DOI (to PDF): https://doi.org/10.4236/ojcd.2017.72005
Paper ID at SCIRP: 76751
Article page: http://www.scirp.org/Journal/PaperInformation.aspx?PaperID=76751
Retraction date: 2017-11-24

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Date initiative is launched: 2017-11-24

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History
Expression of Concern:
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X no

Correction:
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X no

Comment:

Students (Authors) didn't get Prof. Ali Jalili's permission to publish this paper.

This article has been retracted to straighten the academic record. In making this decision the Editorial Board follows COPE's Retraction Guidelines. Aim is to promote the circulation of scientific research by offering an ideal research publication platform with due consideration of internationally accepted standards on publication ethics. The Editorial Board would like to extend its sincere apologies for any inconvenience this retraction may have caused.

Editor guiding this retraction: Prof. Natalia Bizunok (EiC, OJCD)

Open Journal of Clinical Diagnostics, 2017, 7, 45-57
http://www.scirp.org/journal/ojcd
ISSN Online: 2162-5824
ISSN Print: 2162-5816

Studying the Amount of Blood Parameters and Liver Enzymes in the Workers of Sanandaj Power Plant

RETRACTED

Hirash Nadimi[1*], Ali Jalili[2], Khaled Mohammadi[3], Vida Nadimi[4]

[1]Biochemistry, Science Department of Sanandaj Islamic Azad University, Sanandaj, Iran
[2]Department of Immunology & Hematology, Kurdistan University of Medical Sciences, Sanandaj, Iran
[3]DBA Management of Industrial Management Organization of Sanandaj, Research Expert of Vice Chancellor for Resource Management Affairs, Kurdistan University of Medical Sciences, Sanandaj, Iran
[4]Engineering and Food Science, College of Agriculture, Science Department of Sanandaj Islamic Azad University, Sanandaj, Iran

Email: *Hirash1990@gmail.com, Ali130@gmail.com, Kmohammadi39@yahoo.com

How to cite this paper: Nadimi, H., Jalili, A., Mohammadi, K. and Nadimi, V. (2017) Studying the Amount of Blood Parameters and Liver Enzymes in the Workers of Sanandaj Power Plant. *Open Journal of Clinical Diagnostics*, **7**, 45-57.
https://doi.org/10.4236/ojcd.2017.72005

Received: January 19, 2017
Accepted: June 4, 2017
Published: June 7, 2017

Abstract

Previous studies have unraveled the adverse effects of man-made magnetic fields on human and animal health. Controlling hematological parameters is a useful procedure to evaluate the level of health of humans and animals that are exposed to electromagnetic fields. Due to the long-term exposure of power plant workers to strong electromagnetic fields, this research was designed and conducted to compare the hematological parameters of the workers of Sanandaj Power Plant (EPSW) with a control group (the workers of Mehr Bank). For this purpose, whole blood and serum samples were taken from the EPSW (n = 91) and control (n = 88) groups. The collected serum samples were evaluated in terms of the amounts of serum glutamic oxaloacetic transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT); and the blood samples were evaluated in terms of erythrocyte indices. The results indicated that the EPSW group showed higher amounts of SGPT, RDW (Red Cell Distribution Width) and Ly (lymphoma), and lower MCH (Mean Corpuscular Hemoglobin), MCHC (Mean Corpuscular Hemoglobin Concentra-

[1]Corresponding author, Master's student in biochemistry, Science Department of Sanandaj Islamic Azad University, Iran
[2]M.Sc., Ph.D. Chair and Associate Professor Dept of Immunology & Hematology, Kurdistan University of Medical Sciences, Sanandaj, Iran
[3]PhD student of DBA management of industrial management organization of Sanandaj, Research Expert of Vice Chancellor for Resource Management Affairs, Kurdistan University of Medical Sciences, Sanandaj, Iran
[4]Master's student in Engineering and Food Science, College of Agriculture, Science Department of Sanandaj Islamic Azad University, Iran

tion), Ne (Neutrophils) and Mo (Monocyte) in comparison with the control group ($P < 0.05$). There were no significant differences between the two groups in terms of SGOT, WBC, RBC, Hb, HCT, MCV and PLT ($P > 0.05$). Some cases of hematological anomalies were observed in the workers of Sanandaj Power Plant, which confirm the necessity of executing safety precautions in these types of work environment.

Keywords

Electromagnetic Field, Hematology, SGOT, SGPT

1. Introduction

Nowadays due to the increase in electromagnetic wave sources, massive industrial developments, technological transformations and modern lifestyles, humans are more exposed to harmful chemical and physical elements such as satellite antennae, noise generators, power transmission towers, etc [1]. Although many of these elements are new and a result of science, some of them-such as electromagnetic fields-are constant components of nature to which human populations are involuntarily exposed [2] [3]. On the other hand, there is no limit to determine the amount of exposure to these fields. Concerns are rising in this matter and the effects of magnetic fields and power plants on the health of living beings-specifically on humans must be studied [4]. These fields can be harmful to humans in certain intensities and frequencies. Thus, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the National Radiation Research Institute (NRRI) emphasize on radiation and electromagnetic fields and their negative effects on people's health as a major environmental threat [5]. One of these negative effects is the effect of electromagnetic fields on the biological process of living beings [6]. Some researches address the electrocardiogram and electroencephalogram diagrams, changes in cells and blood biochemistry, insulin and T3 disorders, effects on nervous systems, genetic transformations and finally the cancerous growth of cells that are exposed to these fields [7] [8]. Electric and magnetic fields affect all human body organs by penetrating the body, which may cause changes in the membrane potential and distribute ions. These changes might include cell biochemical processes such as biochemical mechanisms, serum enzyme activities and changes in blood parameters. The available data regarding the effects of these fields on human health are inconsistent. This inconsistency is probably caused by choosing different populations and parameters and also by the different conditions in which the exposure has occurred.

The aim of this study is to Study the Amount of Blood Parameters and Liver Enzymes in the Workers of Sanandaj Power Plant in Iran.

2. Literature Review

Most measurements that are taken from different distances of terrestrial antenna indicate that wave power and frequency have a direct relationship with human and environment health. The effects of these parameters vary depending on the power, frequency, duration and time in which the encounter occurs [9]. The following table plots some of the harmful effects of magnetic fields (**Table 1**).

In the study at hand, the effect of presence in a power plant is evaluated on erythrocyte indices (number of erythrocytes, amount of hemoglobin, percentage of hematocrit, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, red blood cell distribution width, and mean corpuscular volume), leukocyte indices (relative number of neutrophils, lymphocytes, monocytes, and the total number of leukocytes), platelet indices (number of platelets), and liver enzymes. Aminotransferase enzymes are measured as the exclusive indicators of the necrosis of liver cells (hepatocytes) in order to diagnose liver diseases. The continuous exposure of humans and animals to electromagnetic fields leads to an increase in the amount of glucocorticoids (cortisols) and oxidative stress results, and causes hypoxia. These are the main reasons of the high amounts of transaminase enzymes in the serums of people who are continually exposed to

Table 1. Some of the harmful effects of magnetic fields.

Source	Harmful effect	Beam generator and target tissue	Type of beam
[9]	Heats up body tissues, boils intraocular fluid		Electromagnetic radiation
[9]	Breaks the chemical bonds of tissues and causes ionization in air molecules	High energy at the time of collision, like the radiography of beams caused by telecommunications equipment	Ionizing and non-ionizing radiation
[10]	Changes in enzyme processes, disorders in calcium exchange and changes in cell growth and proliferation	Increasing body heat without stimulating the heat-sensitive receptors on the skin	Thermal
[10]	Changes in blood chemistry (decreased number of red blood cells), effects on the reproductive system, cancer, neurological disorders, increased irritability, headache, dizziness, nausea, watery eyes	persistent changes in cell structure that can last for years and even pass on to forthcoming generations	Non-thermal
[11]	Significant fever		Thermal effects
[11]	Absorbs electromagnetic energy 400 times more than water in a 11 GHz frequency; following which DNA splits into shorter lengths		Non-thermal effects

electromagnetic fields. Hypoxia can increase the level of AST and ALT enzymes to thousands of units per liter [12]. Electromagnetic waves cause disorder in cell function by disturbing its electric power. The amount and severity of this disorder depends on the abnormalities and the damage dealt [13]. Based on magneto-hydrodynamic findings, electric currents are produced in a conductive fluid that is exposed to a static transverse magnetic field from the outside. The magnetic field and the induced currents produce forces (the Lorentz force) that slow down the blood flow. It is reported in numerous studies that the radiations of electronic equipment are absorbed by human body and converted to heat. This biological effect leads to the persistence of adverse effects in vital organs of human body. For instance, based on a report from the Australian Radiation Protection Agency in 2005, 70% of the waves that are propagated by cellphones are absorbed by the user's head, which lead to an increase in the speed of neural impulses, blood pressure and heart rate. Exposure to electromagnetic waves leads to a lack of balance in the circulatory system, increased blood flow, disorders in blood pressure [14] [15], decreased amount of hemoglobin [16], increased chance of blood cancer in children [17] [18], and a change in blood-brain barriers [19]. Blood is the only tissue that flows in the body. This red fluid transports oxygen and nutrients to all body parts and transfers wastes to lungs, kidneys and liver for excretion. In addition, blood is an important part of the safety system and plays a significant role in the balance of fluids and body temperature and the transfer of hormones [20].

3. Methodology

With the permission of the workers (the experimental group of power plant workers in Iran and the control group of Mehr Bank workers), the survey was filled up with personal information by 88 people selected randomly and 5 cc of blood was taken from them. The blood was taken in Razi laboratory in order to study blood parameters and liver enzymes. Serum samples were separated after centrifuge and kept in the freezer for the experiment. Blood parameters including red blood cells, hemoglobin, white blood cells, mean corpuscular volume and hematocrit, and also liver enzymes including ALT and AST were measured. The raw data collected in this experiment was processed and organized in Excel software, then studied in terms of outliers and the outliers were removed using Minitab 17 software > Stat-Basic Statistics-Outlier (the Grubbs test with a significance level of 5%). The new series of data were examined by normality tests. Parameters with non-normal distributions were prepared for analysis of variance (ANOVA) and comparison of means after data conversion using > Stat-Control charts-Box-Cox. The analysis of variance was done using the statistical software SAS 9.1 and GLM procedure, and the comparison of means was performed by the T-test. According to the content above and the continuous exposure of the workers of facilities such as power plants to electromagnetic radiation, the present study was designed and executed with the purpose of comparing some blood parameters (as health level indicators) between power plant and Mehr

Bank workers. In the following, the findings of this study are presented, interpreted, and compared with the results of other researchers.

4. Results

Aminotransferase enzymes are examined as the exclusive indicators of the necrosis of liver cells (hepatocytes) in order to diagnose liver diseases in the two groups. The results of the comparative analysis of the data regarding the level of AST (or SGOT) and ALT (or SGPT) enzymes in the blood samples of the workers of the power plant and Mehr Bank are plotted in diagrams 1 and 2, respectively. Based on diagram 1, there is no significant difference in the level of SGOT enzyme ($P > 0.05$); however, this parameter clearly tends to increase in the blood samples of the power plant workers in comparison with the workers of Mehr Bank. According to diagram 2 however, the level of the SGPT enzyme is significantly higher ($P < 0.05$) in the blood samples of the power plant workers in comparison with the control group (the workers of Mehr Bank). The comparative analysis of the red blood cell (RBC) count, the amount of hemoglobin (Hb), the percentage of hematocrit (HCT), the mean corpuscular hemoglobin (MCH), the mean corpuscular hemoglobin concentration (MCHC), the red blood cell distribution width (RDW), and the mean corpuscular volume (MCV) in the blood samples of the power plant and Mehr Bank workers are illustrated in diagrams 3 to 9 respectively. The two groups did not have any significant difference in the RBC, Hb, HCT and MCV parameters ($P > 0.05$); however, the MCH parameter for the power plant group is significantly lower ($P = 0.0897$) than the data obtained for the Mehr Bank workers. There were significant differences in the MCHC and RDW parameters between the two groups ($P < 0.05$). The comparative analysis of the white blood cell (WBC) count, the relative number of neutrophils (Ne), the percentage of lymphocytes (Ly) and monocytes (Mo) in the blood samples of the power plant and Mehr Bank workers are plotted in diagrams 10 to 13 respectively. The results indicate no significant differences in the total number of white blood cells between the two groups ($P > 0.05$); but the relative number of neutrophils and monocytes (based on a percentage of the total number of leukocytes) in the blood samples of the power plant personnel is significantly lower than Mehr Bank workers and the relative number is significantly higher ($P < 0.05$). The results of the comparative analysis of blood platelets are given in diagram 14. It is evident in the diagram that the number of platelets in the blood samples of the power plant personnel show no significant difference from the data obtained for Mehr Bank workers (the control group) (Figures 1-14).

5. Discussion

In accordance with our findings, Chakir *et al.* [21] also reported no significant change in the platelet count of the whole blood samples taken from female Wistar rats after exposure to low-frequency magnetic fields. Much like the findings of the experiment at hand, Chakir *et al.* [21] did not observe any significant

Figure 1. Comparison of the level of serum glutamic oxaloacetic transaminase (SGOT) in the blood samples of the workers of Sanandaj power plant and Mehr Bank.

Figure 2. Comparison of the level of serum glutamic pyruvic transaminase (SGPT) in the blood samples of the workers of Sanandaj power plant and Mehr Bank.

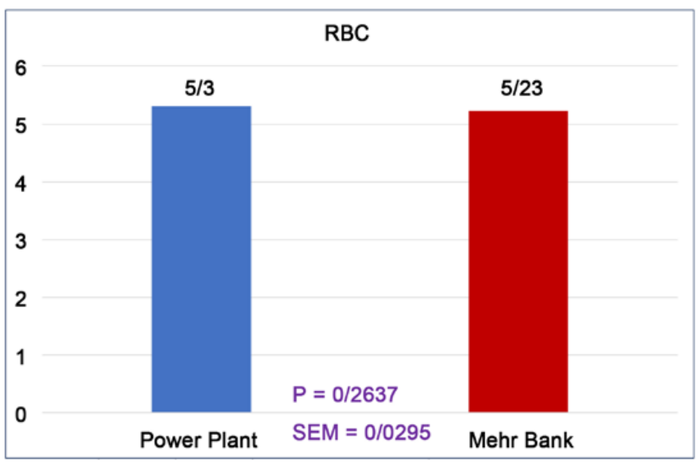

Figure 3. Comparison of the red blood cell (RBC) count in the blood samples of the workers of Sanandaj power plant and Mehr Bank (standard range: 4.5 - 6 × 10^6 per microliter of whole blood).

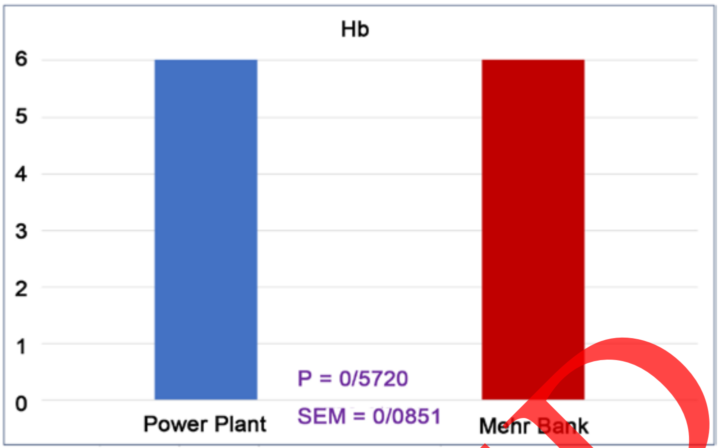

Figure 4. Comparison of the density of hemoglobin (Hb) in the blood samples of the workers of Sanandaj power plant and Mehr Bank (standard range: 13.5 - 17.5 grams per deciliter).

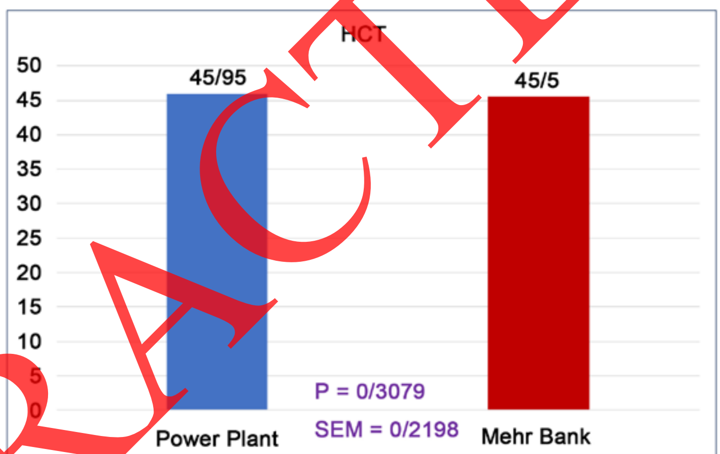

Figure 5. Comparison of the percentage of hematocrit (HCT) in the blood samples of the workers of Sanandaj power plant and Mehr Bank (standard range: 41.5 - 53 percent).

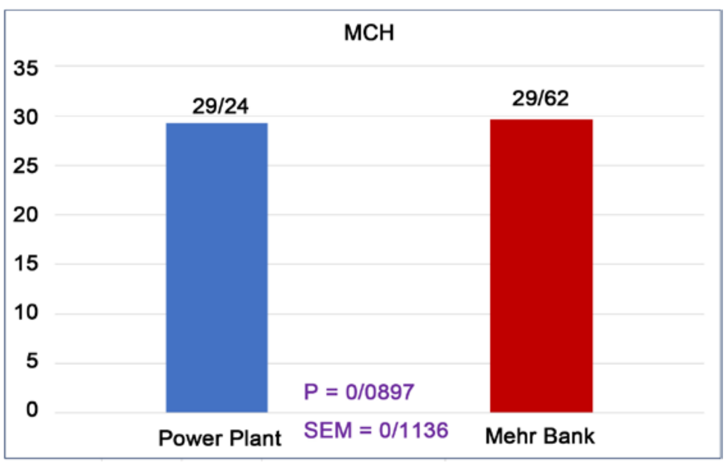

Figure 6. Comparison of the mean corpuscular hemoglobin (MCH) in the blood samples of the workers of Sanandaj power plant and Mehr Bank (standard range: 27.5 - 33.2 pico-grams).

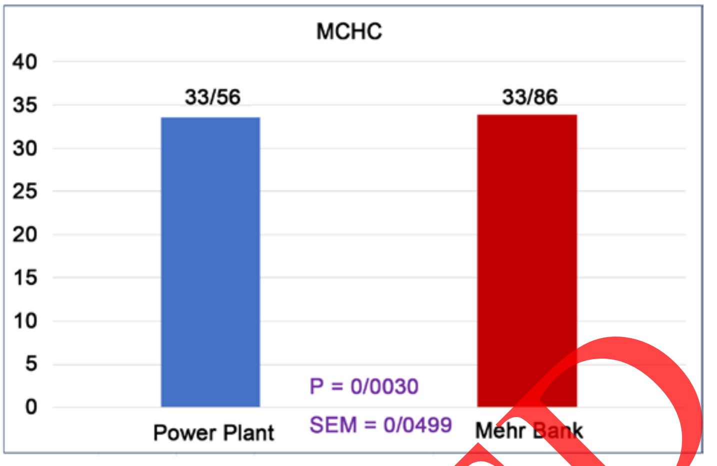

Figure 7. Comparison of the mean corpuscular hemoglobin concentration (MCHC) in the blood samples of the workers of Sanandaj power plant and Mehr Bank (standard range: 33.4 - 35.5 grams per deciliter).

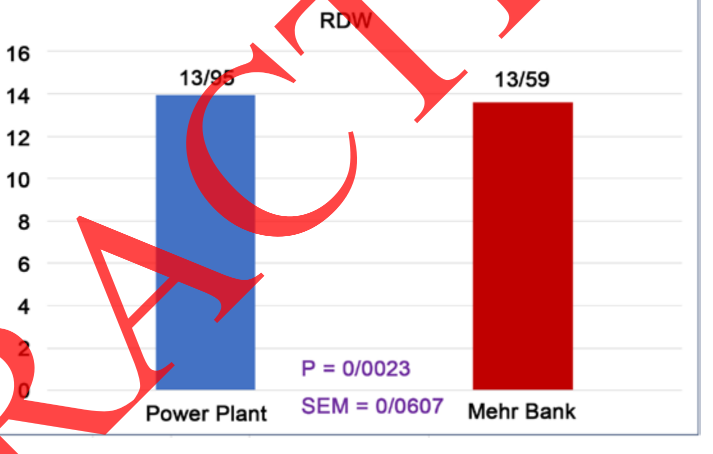

Figure 8. Comparison of the red blood cell distribution width (RDW) in the blood samples of the workers of Sanandaj power plant and Mehr Bank (standard range: 11.5 - 14.6 percent).

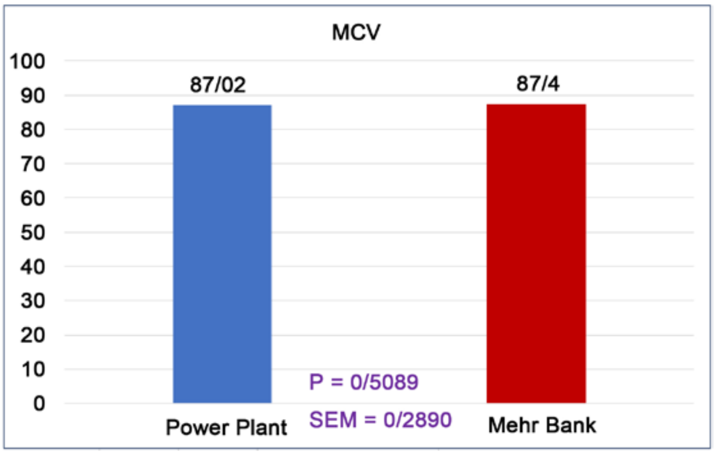

Figure 9. Comparison of the mean corpuscular volume (MCV) in the blood samples of the workers of Sanandaj power plant and Mehr Bank (standard range: 80 - 96 square micrometers).

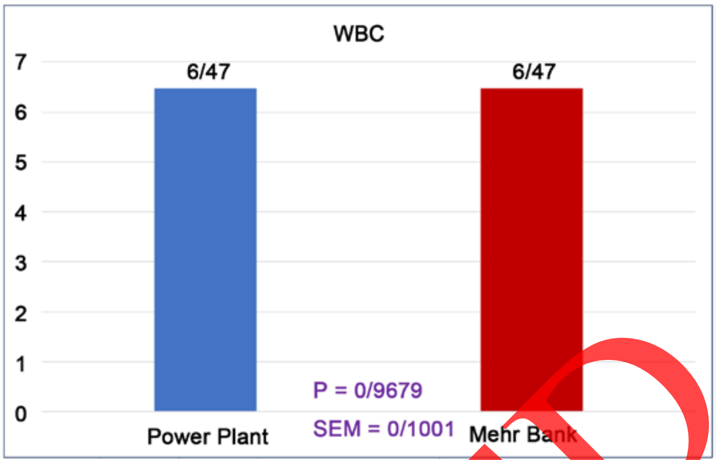

Figure 10. Comparison of the white blood cell (WBC) total count in the blood samples of the workers of Sanandaj power plant and Mehr Bank (standard range: 4 - 10 × 10^6 per microliter of whole blood).

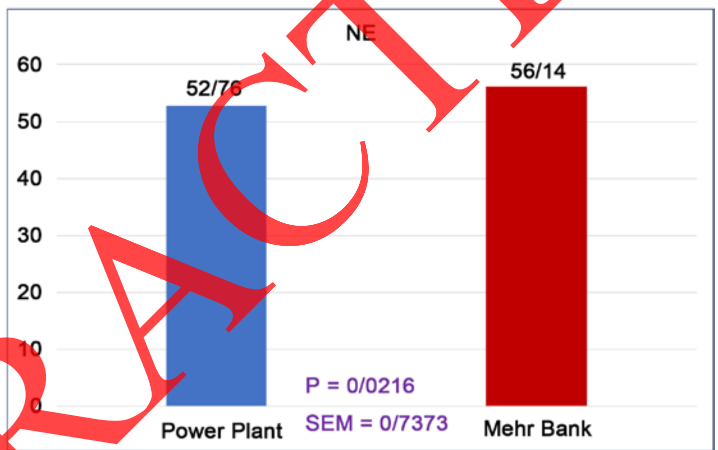

Figure 11. Comparison of the neutrophil count in the blood samples of the workers of Sanandaj Power Plant and Mehr Bank (standard range: 35 - 70 percent).

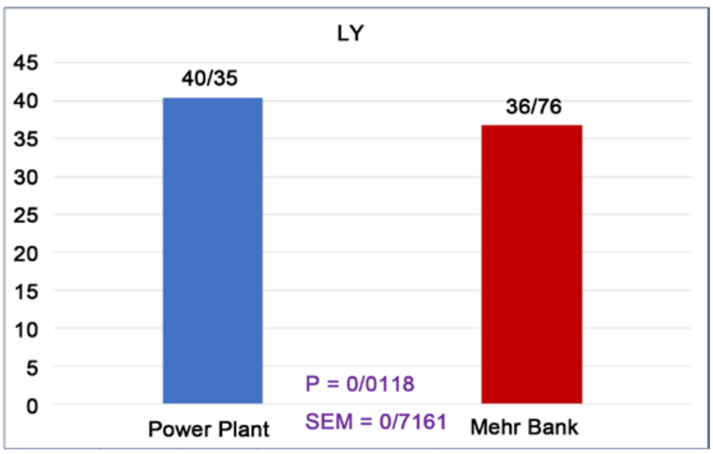

Figure 12. Comparison of the lymphocyte count in the blood samples of the workers of Sanandaj power plant and Mehr Bank (standard range: 24 - 44 percent).

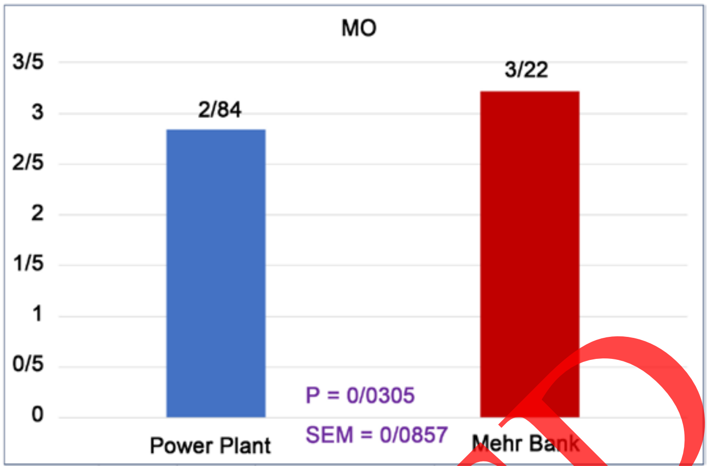

Figure 13. Comparison of the monocyte count in the blood samples of the workers of Sanandaj power plant and Mehr Bank (standard range: 24 - 44 percent).

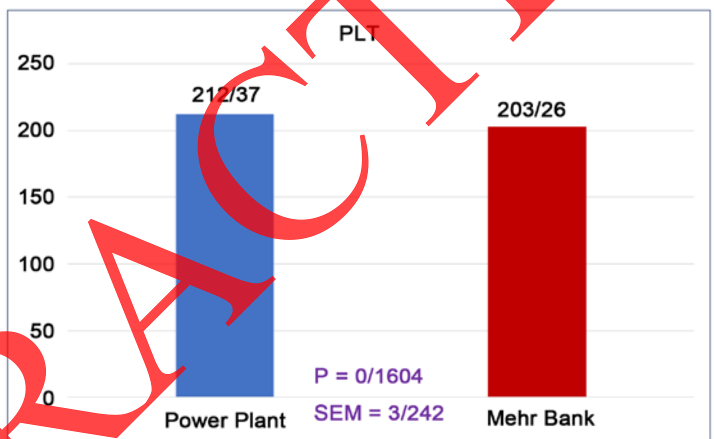

Figure 14. Comparison of the platelet count in the blood samples of the workers of Sanandaj power plant and Mehr Bank (standard range: 140 - 450 × 10^3 per microliter of whole blood).

difference in terms of MCV, HCT and RBC count between the rats in the control group and the rats that were exposed to an electric field (50 Hz, 97 MT) 3 hours a day for 50 and 100 days. However, unlike our observations, the amount of hemoglobin in their blood dropped significantly after 50 days of exposure to electromagnetic fields. Also in contradiction with our findings, the parameters RDW, MCH and MCHC in this study did not show a significant response to being exposed to electric fields. In the study we referred to, significant changes are observed after 50 days of exposure to electromagnetic fields and then vanished in the hundredth day of the experiment. This can be attributed to the adaptability of the hematopoietic system to long-term exposures to electromagnetic fields. Since the personnel of the power plant in our study have had a relatively long and continuous presence in their workplace, it is not unlikely that the lack of a significant difference in some parameters is somehow a result of the adaptability of the hematopoietic system.

6. Conclusion

Thus in this study, we might be able to attribute the increase of RDW and the decrease of MCH and MCHC in the blood samples of power plant workers to the increase of immature blood cells. In addition, the adverse effects of artificial electromagnetic fields on the red bone marrow and the erythrocyte production process are already proved (Shekarooghloo *et al*., 2013; Jelodar *et al*.). The insignificant decrease of the WBC count and the relative count of lymphocytes, neutrophils, monocytes and basophils were some of the findings of Chakir *et al*. (2009) who studied the hematological changes of rats when exposed to magnetic fields with very low frequencies (50 Hz). In another study, CBA mice were exposed to an electromagnetic field (50 Hz) for 20 days and showed a significant decrease in the number of mononuclear leukocytes (monocytes and lymphocytes) [22]. Since Kupffer cells have a roll in the decomposition of red blood cells and their conversion to bilirubin, increasing the number of Kupffer cells can lead to an increase in the production of bilirubin. In another study, Buguslaw *et al*. studied the effects of electromagnetic fields on the biochemical parameters of serums for the workers of a steel factory. The results indicated a significant decrease in the level of protein, globulin and the activities of aspartate dehydrogenase; but the activities of alanine aminotransferase remained unchanged. The total lipid, cholesterol, triglyceride, pre-lipoprotein decreased and lipoprotein increased. The results of this study suggested the effect of electromagnetic waves on the liver of workers who were exposed to them. The evident decrease in the level of protein and globulin might be a sign of the chronic inflammation process [23]. Jimenez Garcia *et al*. (2010) showed that the exposure of rats to rays with a frequency of 120 Hz and an intensity of 4.5 milli-Tesla reduces cell proliferation and thus prevents the destruction of the induced neoplastic by the chemical agents in the rat's liver. This study has also expressed that the exposure of the rats to electromagnetic fields does not cause apoptosis in liver cells [24].

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