

# Electromagnetic Fields of Mobile Phone Jammer Exposure on Blood Factors in Rats

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## ABSTRACT

**Background:** The increasing demand for using mobile phones has led to increasing mobile phone jammers as well. On the other hand, reports show that exposure to electromagnetic field causes an increase in the incidence of diseases such as leukemia, cancer, depression and failure in pregnancy outcomes; therefore, the aim of this study is to investigate the effects of exposure to electromagnetic fields of mobile phone jammers on blood factors.

**Materials and Methods:** Thirty male Wistar immature and thirty mature rats were selected randomly and each one was divided into three groups of ten. The control group did not receive any radiation; the sham group was exposed to a switched-off jammer device and the experimental group was exposed to electromagnetic fields (EMF) radiated by Mobile Phone Jammer daily eight hours for five days a week during forty days. Blood sample was taken from heart and blood factors including PLT, MCHC and RDWCV were measured. The data were analyzed by ANOVA which was followed by Duncan's test.

**Results:** The data from mature rats revealed that jammer usage led to a significant difference in blood factors including RBC, platelet, hemoglobin, hematocrit, MCV and RDWCV ( $P \leq 0.05$ ); however, the number of lymphocytes, WBC and MCVH in the blood was the same in all groups. In immature rats, the exposure to jammer did not change RBC, lymphocyte and WBC count, hemoglobin and hematocrit; while, the platelet count along with MCHC, MVC and RDWCV changed by jammer radiation.

**Conclusion:** The results exhibited that mobile phone jammer caused frequent changes in blood cell factors.

## Keywords

Electromagnetic Field (EMF), Radiation, Mobile Phone Jammer, Blood Cell Factors

## Introduction

**N**on-Ionizing radiation (NIR) is radiant energy with long wavelengths more than 100nm and low-energy photons (12.4eV). These rays appear on the electromagnetic field (EMF) spectrum. EMF wavelength is between 1 Hz to  $3 \times 10^{15}$  Hz. EMF contains the microwave, very high frequency and low frequency radio waves; these are called radiofrequency waves as well. NIR hits tissues, and generates heat. The absorption characteristics of the radiation in different body tissues are dependent on the penetration, duration of exposure and

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biological properties of the irradiated tissues [1]. One application of EMF is telecommunication. Nowadays, cell phones have a wide use in society but they have caused problems related to disturb people or community security. Therefore, one of the ways to stop this disruption is using jammer devices. Mobile Jammer device uses radio waves radiation with the same frequency of global system mobile (GSM) to prevent from receiving signals of base station by cellular phones. Cell phones work through base stations with their service networks. When jamming is effective, the jammer power will be equal to the signal power at the receiver. A jammer device usually emits radiation and people who attend those places expose to it [2].

Studies have shown that electromagnetic fields emitted by mobile phones cause disorders in learning, memory [3], sleep patterns [4] and disturbance in neurotransmitter release [5], blood-brain barriers [6] and also led to cancers and other diseases [7-8]. Electromagnetic fields emitted by mobile phones may change the content of the reactive oxygen species (ROS) in cells [9]. Moreover, a few studies showed that cell phones radiation interfered with endocrine system and changed the level of some hormones in serum [10] such as progesterone [11] or thyroid hormones [12].

The aim of the current study is to investigate the impact of radiation emitted of mobile phone jammers on hematological factors (blood cell factors and count), including red blood cell indices, mean corpuscular hemoglobin concentration (MCHC), a parameter that measures the concentration of hemoglobin in RBC [13]. Another blood factor is the red blood cell distribution width (RDW-CV) which is the variation of RBC volume. It is an index of deviation in RBC size inside blood sampling [14].

## Materials and Methods

The experimental design was approved by the Ethics Committee of the University. 30

male adult Wistar rats, weighing 200-250 g and thirty immature Whistar rats were randomly divided into six groups of 10; including two control groups with any treatment (adult and immature), the sham group exposed to a switched-off jammer device (adults and immature), and experimental group exposed to a switched-on jammer radiation (adult and immature). Sham and experimental groups were kept at the distance of 50 cm from the jammer antenna. The jammer device used in this study (model MB06) was capable of blocking mobile communications within distance up to 40 meters. In addition, sham (off-condition) & experimental (on-condition) groups were exposed to electromagnetic fields (EMF) by Mobile Phone Jammers five days a week for forty days. The daily duration of the exposure to radiation was eight hours.

## Serological Analysis

A day after conducting the experiment, blood samples were taken from heart under Anastasia, the serum was separated through centrifugation at 3000 rpm and frozen until used. The number of the platelets, lymphocytes and RBCs were counted and blood factors including Hematocrit, Hemoglobin, MCHC and RDWCV were measured by Sysmex automated CBC analyzers.

## Statistical Analysis

The data were analyzed by ANOVA followed by Duncan's test. SPSS 16.0 for windows was used to analyze the data. Excel was used to depict the graphs. P-value less than 0.05 was considered as a significant difference.

## Results

The statistical analyses revealed no significant changes in the lymphocyte and WBC counts. The statistical analyses revealed that the exposure to jammer on- (experiment) or off- (sham) radiation in adult rats led to a significant increase in RBC ( $P=0.001$ ) and platelet counts ( $P=0.001$  and  $0.02$ , respectively)

compared to control rats. Hematocrit and hemoglobin contents and MCV exhibited a significant increase in jammer-treated animals compared to the control but not with the sham ( $P=0.002$ ,  $P=0.001$  and  $P=0.001$ , respectively). MCHC was statistically comparable in experimental and sham animals. However, it was shown a significant increase in sham animals compared to that in control rats ( $P=0.014$ ). RDWCV showed a significant decrease in jammer-treated animals relative to control ( $P=0.029$ ) and a significant increase compared to sham animals ( $P=0.002$ ). The values of all data are summarized in Table 1.

In immature rats, RBC, WBC and lymphocyte counts were the same in all groups. Besides, the hemoglobin content and hematocrit did not change significantly by exposure of the rate with jammer on- or off-device. Platelets and MCHCs showed a significant reduction in jammer-treated rats compared with those in both the sham and the control rats ( $P=0.001$  for platelet and  $P=0.015$  and  $0.022$  for MCHC, respectively). MCV exhibited a significant reduction in experimental rats compared to the sham but not with the control ( $P=0.004$ ). RDWCV showed an increase in value in experi-

mental group compared to both the control and the sham ( $P=0.001$ ). RDWCV also revealed a significant increase in the sham compared with the control as well ( $p=0.001$ ). The values of all data are summarized in Table 2.

## Discussion

Literature review demonstrates jammer radiation exerts both beneficial and detrimental effects on different organs. The current study came to the conclusion that turned-on jammer led to an increase in both platelets and RBC, but not WBC, and lymphocyte numbers in mature rats compared to those exposed to turned-off sham rats. However, up to the best of our knowledge, there are no studies which focus on the influence of turned-on or -off jammer exposure on the number of blood cells in rats. However, the effects of radiofrequency on the blood cell count have been addressed in the past. It has been reported that the exposure of humans to commercial mobile phones for 30 minutes has no influences on lymphocyte count; our data showed the same result with jammer radiation as well [15]. No difference in RBC count has been reported in human exposed to EMF [16] which is in contrast with

**Table 1:** The effect of electromagnetic fields (EMF) by Mobile Phone Jammers on blood factors in mature rats.

	Sample Size	Control Mean $\pm$ SD	Sham Mean $\pm$ SD	Exposed Mean $\pm$ SD	Sig (P-Value)
PLT ( $\times 10^3/\mu\text{L}$ )	10	457.50 $\pm$ 251.78 a	741.10 $\pm$ 128.32 b	740.800 $\pm$ 267.293 b	0.011
MCHC (g/dL)	10	6.83 $\pm$ 31.76 a	25.94 $\pm$ 19.93 a,b	33.50 $\pm$ 0.95 b	0.029
RDWCV	10	16.55 $\pm$ 0.96 b	14.99 $\pm$ 2.34 a,b	14.44 $\pm$ 1.24 a	0.021
LYM (cell / $\mu\text{L}$ )	10	84.30 $\pm$ 5.30 a	83.05 $\pm$ 4.53 a	84.50 $\pm$ 6.22 a	0.81
Hgb (g/dL)	10	13.92 $\pm$ 1.78 a	16.17 $\pm$ 0.74 b	15.05 $\pm$ 1.31 a,b	0.004
Hct = (%)	10	44.97 $\pm$ 4.853 a	50.32 $\pm$ 2.81 b	45.01 $\pm$ 4.57 a	0.011
WBC ( $10^3$ cell/ $\mu\text{L}$ )	10	13.42 $\pm$ 6.49 a	13.39 $\pm$ 3.69 a	13.20 $\pm$ 3.66 a	0.994
RBC ( $10^6$ cell/ $\mu\text{L}$ )	10	7.30 $\pm$ 0.81 a	8.58 $\pm$ 0.31 b	7.78 $\pm$ 0.768 a	0.001

PLT = platelet count ( $\times 10^3/\mu\text{L}$ ); LYM = lymphocyte count (cell / $\mu\text{L}$ ); MCHC = mean corpuscular hemoglobin concentration (g/dL); RDWCV = red blood cell distribution width; Hgb = hemoglobin; WBC = white blood cell count; RBC = red blood cell count; Hct = (% Hematocrit level)

**Table 2:** The effect of electromagnetic fields (EMF) by Mobile Phone Jammers on blood factors in immature rats.

	Sample Size	Control Mean±SD	Sham Mean±SD	Exposed Mean±SD	Sig (P-Value)
PLT ( x10 <sup>3</sup> /μl)	10	777.30±266.45 b	721.20±89.29 b	361.30±216.35 a	0.000
MCHC (g/dL)	10	33.49±1.06 b	32.15±0.60 a,b	11.38±33.33 a	0.027
RDWCV	10	13.42±1.14 a	12.63±0.66 a	18.94±0.76 b	0.000
LYM (cell /μL)	10	76.48±9.15 a	84.77±3.01 b	85.36±2.70 b	0.004
Hgb (g/dL)	10	15.20±1.19 a	15.86±0.66 a	15.39±2.16 a	0.596
Hct =(%)	10	45.33±2.53 a	49.35±1.49 a	49.60±6.32 a	0.043
WBC (10 <sup>3</sup> cell/μL)	10	10.41±4.61 a	15.41±5.53 a	14.13±38.87 a	0.003
RBC (10 <sup>6</sup> cell/μL)	10	6.55±3.07 a	8.20±0.30 a	8.21±1.04 a	0.093

PLT = platelet count (x10<sup>3</sup>/μl); LYM = lymphocyte count (cell /μL); MCHC = mean corpuscular hemoglobin concentration (g/dL); RDWCV = red blood cell distribution width; Hgb = hemoglobin; WBC = white blood cell count; RBC = red blood cell count; Hct = (% Hematocrit level)

the result obtained by jammer exposure. There is a contradictory result about the change in platelet count after exposure to EMF. A study demonstrated that the number of platelets was not influenced by 30 minutes of exposure to a smartphone cell [17]. Other reports on rabbits exposure to EMF showed a decrease in the platelet count [18-19]. In young men, exposure to EMF did not lead to any changes in platelet count [20-22]. Our result exhibited jammer usage led to a significant increase in platelet count in turned-on/ jammer respect to the control. The difference in the data might be attributed to the difference in the functional mechanism of two devices (EMF vs. jammer radiation) on blood tissue or different species.

The Current data showed that MCHC increased in the mature group exposed to off-jammer device respect to the control group. It has been reported that short-term and long-term exposure of mature rats to ELFEMF had no impact on MCHC [23]. Our result with jammer on-exposed rats confirmed the aforementioned report. Another study reported that higher power of the electromagnetic field exposure (6 W) to rabbits elevated MCHC compared to the control group [18]. Our result in

jammer-off-exposed rats was along with the aforementioned reports. Such a contradictory result might be due to the nature of the radiation produced by jammer or EMF devices. It seems that jammer radiation neutralized the effects of radiofrequency waves on MCHC.

The results from mature rats prove a significant decrease in RDWCV and increase in hemoglobin content of the group exposed to the on- and off-jammer compared to the control group. In EMF exposed rabbits [18] and young humans [21], hemoglobin content and RDWCV have did not change significantly. Short-term exposure of rats treated with ELF-EMF was detected to lead to a decrease in hemoglobin content. However, in long term, it had no significant impacts [23]; we detected that both short-term and longterm exposure of rats to ELFEMF had no influence on RDWCV 23. Our results were in contrast with the results obtained by Cakir et al. and which might be due to the blocking effects of jammer radiation on ELFEMF.

Hematocrit also increased in an on-jammer device exposed rats compared to control conditions. A decrease in hematocrit value was reported previously by treating the rats with

EMF [24] that is in contrast with our results. Yet, there is a report on human which shows EMF has no significant effects on hematocrit [20-21]. Therefore, it seems that the effect of non-ionizing radiation on blood parameters depends on the species, duration, intensity and the source of radiation.

Blood parameter changes by exposure of immature rats to jammer radiation were different from those in mature ones. For instance, the platelet count reduced in immature rats and it increased in mature rats compared to the control and the sham. In mature rats, RBC revealed an increase in numbers compared to control rats, However, in immature ones, RBC count was the same in all groups. These differences in the effect of jammer radiation might be attributed to different rates of hematopoiesis, the number and differentiation potentials of hematopoietic stem cells in mature and immature rats. Besides, the body water content decreases from neonatal life towards adulthood [25]. The water content of the body influences the penetration rate of EMF radiation [26] and as a result it might modulate its effect on the tissue.

## Conclusion

Based on the results of the present study, it can be concluded that exposure of mature rats to mobile phone jammer radiation caused significant differences in platelets, hematocrit and hemoglobin, RBC, MCHC, MCV and RDWCV compared to the control group. In immature rats, the jammer exposure had no significant effects on hematocrit, hemoglobin as they change in the mature ones. It also modified blood parameters in mature and immature rats in different ways.

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## Conflict of Interest

None Declared

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