



## Effects of electromagnetic field radiation on biochemical parameters in swiss albino mice

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**Abstract.** This study investigated the effects of electromagnetic field radiated from mobile phones with frequency between 500 to 900 MHz on some biochemical parameters in 60 swiss albino mice which divided in three groups (one control and two tests). Test groups were exposed to electromagnetic wave twice a day for 20 and 40 days. Blood samples were prepared from heart and Total Protein, Albumin, Blood Urea Nitrogen (BUN), Creatinine Phosphokinase (CPK), Cholesterol, Creatinine, Glucose, Alanin Amino Transferase (ALT), Aspartate Amino Transferase (AST), Alkaline Phosphatase (ALP), Amylase, Lipase, Thyroid Stimulating Hormone (TSH), T<sub>3</sub> and Tyroxin (T<sub>4</sub>) were measured and statistically analysed. According to the results, long time electromagnetic field radiation caused a significant decrease in serum creatinine, glucose, total protein, albumine, cholesterol, T<sub>4</sub> and body weight. The amount of Serum BUN, CPK, ALP, ALT, AST, TSH and T<sub>3</sub> significantly increased. Electromagnetic radiation has influence on biochemical parameters in mice and may effected on healthy.

**Keyword:** electromagnetic field radiation, biochemical parameters, Swiss albino mice.

### Introduction

Electromagnetic radiation refers to the waves of the electromagnetic field, radiating through free space carrying electromagnetic energy.

Different types of EM radiation that make up the electromagnetic spectrum includes radio waves, microwaves, infrared, sun light, visible light, ultraviolet, X-rays, and gamma radiation.

The Radio Frequency (RF) is electromagnetic waves in this frequency range between 500 Hz–100 GHz.

Today, phenomenon of electromagnetism has gained more importance in modern technology.

They have a wide range of application in all electrical fields and equipment like cordless communication systems.

These wireless technologies greatly enhance the ability of human to communicate with each other.

The widespread use of wireless technologies in radiofrequency and electromagnetic field may cause biological effect.

In recent year, some investigations evaluate the biological effects of radio

wave in human and animals [JOLANTA *et al.*, 2001, WEISBORT *et al.*, 2003, BONHOMME-FAIVRE *et al.*, 2003, MORTAZAVI *et al.*, 2009, GROZEA *et al.*, 2016].

Biological effect does not mean health hazard.

Long-time exposure to non-ionizing electromagnetic radiation can affect sensitive organs, which depends on radiations intensity, frequency, and exposure duration [GOLDINI, 1994].

Little is known about health hazards from exposure to non-ionizing electromagnetic radiation.

In spite of years of research, researchers cannot find a confirmed correlation between biological effects of electromagnetic radiation and particular human health hazard and there is still a great controversy regarding the possibility of induction of any significant clinical abnormality [REIPERT *et al.*, 1997, HATCH *et al.*, 1998, LACY-HULBERT *et al.*, 1998, DAY, 1999, BUTU, *et al.*, 2014c, BUTNARIU, *et al.*, 2015a, RODINO, *et al.*, 2014, BUTNARIU, *et al.*, 2016].

This study was conducted to evaluate the influence of long term electromagnetic wave irradiation on some blood biochemical parameters of Swiss Albino mice as surrogate.



### Material and methods

The study was carried out on sixty healthy Swiss albino mice (30 male and 30 female), one month old and weighing  $30 \pm 5$  gram.

The animals were obtained from Animal House Center of Ahwaz Jondishapur University of Medical Sciences, Ahwaz, Iran and kept two weeks prior to study.

The animals were kept in clean polycarbonate cages (4 animals / cage) and maintained under laboratory standard controlled conditions of temperature ( $20 \pm 2$  ° C), light (12–h light and 12–h dark cycle) and relative humidity ( $55 \pm 5$  %).

They were feed by standard balanced food and water was supplied continuously. The experimental protocol was approved by Animal Ethics Committee of Ahwaz Jundishapour University of Medical Sciences.

The mice were divided into three equal groups (one control and two tests).

The first test group (10 male and 10 female) were exposed by mobile phone electromagnetic irradiation with constant frequency in a range between 500 to 900 MHz.

The radio wave was produced by two mobile phones in conversation mode.

Radiation took place two times (2 hours in each time) per day for 20 days.

The second test group (10 male and 10 female) was exposed by electromagnetic wave in similar condition like first group for 40 days.

The control group (10 male and 10 female) was kept in the same environmental condition and feeding like test groups without any irradiation.

At the end of irradiation period, for biochemical analysis all mice in each group were weighted and anesthetized with ether inhalation and the blood samples were collected by taking blood directly from the heart into tubes without any anticoagulant agent [DOROSTGHOAL *et al.*, 2013, [BUTU, *et al.*, 2015, BUTNARIU, *et al.*, 2015b]

The tubes were centrifuged at 3500 rpm for 5 minutes.

Serum samples were separated in micro tubes and kept in  $-20$  centigrade before analysis.

In all samples, Total Protein, Albumin, Blood Urea Nitrogen (BUN), Creatine Phosphokinase (CPK), Cholesterol, Creatinine, Glucose, Alanin Amino Transferase (ALT), Aspartate Amino Transferase (AST), and Alkaline Phosphatase (ALP) were measured in serum samples by biochemistry Autoanalyzer (Global 240, BPC, Italy).

Amylase, Lipase, Thyroid Stimulating Hormone (TSH),  $T_3$  and Tyroxin ( $T_4$ ) were measured in serum samples by using appropriate the enzyme–linked immunosorbent assay (ELISA) (Elisys UNO Germany).

To compare test groups with control group, statistical analysis was done using one–way analysis of variance (ANOVA) followed by Tukey's test.

Data were presented as mean  $\pm$  standard deviation (SD) and  $P < 0.05$  were considered to be significant.

Statistical analyses were done by using SPSS statistics 16 for windows (statistical package for social sciences Inc, Chicago, IL, USA).

### Results and discussion

Table 1 demonstrates the change in biochemical parameters of Swiss albino mice upon exposure to electromagnetic wave.

Creatine Phosphokinase (CPK) is an indicator for cardiac function.

The results show that in comparison with control group CPK was significantly increased in second test group ( $P < 0.05$ ). Blood Urine Nitrogen (BUN), Total Protein and Creatinine are used to access renal function.

Results show that BUN was significantly increased but Total protein was significantly decreased in second test group ( $P < 0.05$ ).

No significant difference was seen in concentration of Creatinine between control and test groups.

Alanin Amino Transferase (ALT), Aspartate Amino Transferase (AST), and Alkaline Phosphatase (ALP) are liver



enzymes and can be used as hepatic function indicator.

These enzymes were significantly increased in exposed mice ( $P < 0.05$ ).

Thyroid Stimulating Hormone (TSH),  $T_3$  and  $T_4$  are thyroidal hormones.

TSH and  $T_3$  were significantly increased but  $T_4$  was decreased in second test group in comparison with control group ( $P < 0.05$ ).

**Table 1.**

Mean values (Mean  $\pm$  SD) of Body weight, BUN, Creatinine, ALT, AST, Glucose, Cholesterol, Total Protein, Albumin, TSH,  $T_3$ ,  $T_4$ , CPK, ALP, Amylase and Lipase in the control, 20 Day exposures and 40 Day exposures.

| Variable               | Control group        | Test group<br>20 Day exposures | Test group<br>40 Day exposures |
|------------------------|----------------------|--------------------------------|--------------------------------|
| Body weight (g)        | 79.411 $\pm$ 8.161   | 75.325 $\pm$ 5.114             | 64.282 $\pm$ 9.263             |
| BUN(mg/dL)             | 18.802 $\pm$ 1.093   | 21.123 $\pm$ 0.746             | 27.000 $\pm$ 0.834             |
| Creatinine(mg/dL)      | 0.627 $\pm$ 0.054    | 0.611 $\pm$ 0.040              | 0.582 $\pm$ 0.087              |
| ALT(Unit/mL)           | 92.800 $\pm$ 13.259  | 92.912 $\pm$ 17.154            | 101.664 $\pm$ 55.942           |
| AST(Unit/mL)           | 187.500 $\pm$ 59.495 | 225.753 $\pm$ 37.2000          | 249.332 $\pm$ 153.000          |
| Glucose (mg/dL)        | 23.372 $\pm$ 0.003   | 12.564 $\pm$ 2.085             | 7.360 $\pm$ 0.002              |
| Cholesterol(mg/dL)     | 75.204 $\pm$ 7.223   | 72.127 $\pm$ 5.846             | 65.500 $\pm$ 5.199             |
| Total Proteine (mg/dL) | 5.684 $\pm$ 0.252    | 5.522 $\pm$ 0.238              | 5.168 $\pm$ 0.253              |
| Albumin (mg/dL)        | 3.249 $\pm$ 0.052    | 3.185 $\pm$ 0.120              | 3.063 $\pm$ 0.081              |
| TSH ( $\mu$ IU/mL)     | 0.234 $\pm$ 0.314    | 0.445 $\pm$ 0.252              | 0.483 $\pm$ 0.256              |
| $T_3$ (ng/mL)          | 0.623 $\pm$ 0.214    | 0.690 $\pm$ 0.429              | 0.730 $\pm$ 0.124              |
| $T_4$ ( $\mu$ g/dL)    | 2.420 $\pm$ 0.532    | 2.27 $\pm$ 0.714               | 2.012 $\pm$ 0.509              |
| CPK(IU/L)              | 4.930 $\pm$ 0.142    | 5.290 $\pm$ 0.574              | 5.342 $\pm$ 0.001              |
| ALP(IU/L)              | 321.312 $\pm$ 0.989  | 334.809 $\pm$ 0.485            | 350.784 $\pm$ 0.798            |
| Amylase (U/L)          | 70.131 $\pm$ 0.854   | 69.423 $\pm$ 0.953             | 69.369 $\pm$ 1.154             |
| Lipase(U/L)            | 43.354 $\pm$ 0.567   | 39.962 $\pm$ 0.852             | 40.539 $\pm$ 0.968             |

Significant decrease of body weight, serum glucose, cholesterol was seen in test groups compare with control group ( $p < 0.05$ ).

Results show no significant difference in Amylase and Lipase between control and test groups.

Blood haematological and biochemical parameters are one the most important factors in evaluation of the health status in human beings and animals.

This paper was conducted to evaluate the effects of mobile phone electromagnetic field on some blood biochemical parameters.

Some investigations have also studied the effect of electromagnetic wave radiation on blood parameters.

Despite a lot of research, the question of whether exposure to radio wave radiation that emitted by mobile phones affects on human health or not, remains unsolved.

In this regard, some investigations reveal that mobile phone electromagnetic waves can affect on different biologic organs like liver [GHAEDI, *et al.*, 2013], Thyroid glands [MORTAZAVI *et al.*, 2009] and reproductive organs [WEISBORT *et al.*, 2003] and some studies investigated different therapeutic actions reducing the potential effect of electromagnetic waves on biosystems [ABDEL-AZIZ *et al.*, 2010].

Occurrence of bad reactions following radiofrequency in biosystems could indicate that these waves might be harmful.

In our study, we noticed that under influence of electromagnetic irradiation weight gain was significantly decreased, which is similar to some investigations [WILSON *et al.*, 1999, GERARDI *et al.*, 2008, ABDEL-AZIZ *et al.*, 2010, BUTNARIU and CORADINI, 2012, CAUNII, *et al.*, 2015, BUTNARIU, *et al.*, 2012].

Our results showed that radio wave exposure decreased total protein levels suggesting the change in protein metabolism of stressed mice.



The significant increase in ALT, AST, and ALP in exposed mice showed probably hepatic damage and free radical action. Our findings corroborate the results of [JELODAR *et al.*, 2013, RIFAT *et al.*, 2014].

Results showed significant differences in the concentration of TSH, T<sub>3</sub> and T<sub>4</sub> between the exposed mice and the control group.

According to the results, it may be concluded that radio waves may cause some detrimental effects on thyroid function.

Results of this study are in agreement with the findings of other researchers [MORTAZAVI *et al.*, 2009, ELSAYED and JASTANIAH, 2016, BUTNARIU and GIUCHICI, 2011, BUTU, *et al.*, 2014a, BUTNARIU, and BOSTAN, 2011].

The present data showed that exposure to radio waves has a significant increase in the level of BUN.

It is similar to findings of some investigators [ABERUMAND *et al.*, 2016].

Free radicals and oxidative stress are the major cause of significant change in the mean level of Serum Glucose, Cholesterol, Total Protein, Albumin and CPK of exposed group compared control group [BUTNARIU, 2012, PETRACHE, *et al.*, 2014, BUTU, *et al.*, 2014b].

This experiment was performed in accordance with the provisions the Helsinki Declaration, which forever altered the ethical landscape of human clinical research, and Basel Declaration.

The aim of the Basel Declaration is to bring the scientific community together to further advance the implementation of ethical principles such as the 3Rs whenever animals are being used and to call for more trust, transparency and communication on the sensitive topic of animals in research (<http://www.basel-declaration.org/basel-declaration-en/?LinkServID=FE726D60-8567-43A0-B7DEFEE404368C4A>).

## Conclusions

The main aim of this study was to evaluate the effect of electromagnetic radiation (500–900MHz) on some blood biochemical parameters in Swiss Albino mice.

In conclusion, based on this animal model study, electromagnetic radiation

has significant effects on the blood biochemical parameters of mice.

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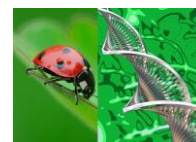
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