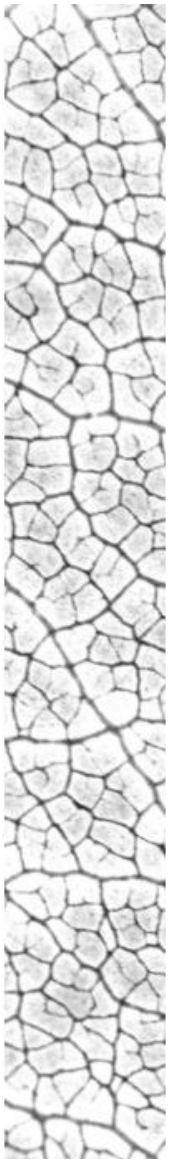

EurAsian Journal of BioSciences
Eurasia J Biosci 14, 3869-3873 (2020)

Study the electromagnetic radiation effects on testicular function of male rats by biochemical and histopathological

Ban Mohammed Hussein Ali [1*]

[1] Horticulture and Garden Engineering Department, College of Agriculture, Al- Qassim Green University, IRAQ
*Corresponding author: ban_altaei7931@yahoo.com

Abstract
The mobile phone has become not only a communication tool, but a necessity of life. Indeed, the widespread use of radio-frequency (RF-EMR) electromagnetic radiation from a mobile phone has higher significant concerns about the negative effects of RF-EMR from mobile phones as well as the random distribution of radio-base stations (base), especially in Iraq. The present study has been prepared to investigate the effects of RF-EMRs emitted from mobile phone and radio-generating stations on the testes. Wistar male mice weighing 180g - 200g were randomly assigned and divided into groups: the sham-exposed group (off mode) and the exposure group for 1/2 hours (the exposure for 1/2 hour), and the 1-hour exposure group (1 hour exposure and 2 hour exposure range (2 hour exposure). Animals were exposed to RF-EMR from Samsung Note 9 for 14 days. Biochemical and histological measurements were performed. Serum levels of male sex hormones (follicle-stimulating hormone and testosterone) decreased significantly ($P < 0.05$) in the exposure groups 1/2 H and 1 H compared to the sham-exposed group. The study shows that chronic exposure to RF-EMR from a cell phone causes the impaired testicular function accompanied by a decrease in the value of sexual hormones. Sperm microscopy also showed a decrease in sperm count, altered shape and development in the experimental groups. Also, changing histological parameters showed a change in cross-section, luminal and bacterial epithelium diameter in all experimental groups.

Keywords: radio-frequency electromagnetic radiation, follicle-stimulating hormone, testosterone, sex hormones, mobile phone

Ali BMH (2020) Study the electromagnetic radiation effects on testicular function of male rats by biochemical and histopathological. Eurasia J Biosci 14: 3869-3873.

INTRODUCTION

The electromagnetic spectrum consists of ultraviolet radiation, X-rays, gamma rays, and the electromagnetic field (EM) occurs when charged particles are accelerated and transported from one point to another in space (Maoquan et al., 2008; Hemayatkhah et al., 2012). The microwave spectrum is used in mobile phones and has an average frequency of about 900 MHz to 1 GHz (Hajiuon, 2014).

Some studies have included electromagnetic radiation generated from common household appliances such as microwave ovens, wireless devices, and electronics, which have also been shown to be carcinogenic (Saygin M et al 2011, Lin YY et al. 2018).

Many scientific studies have warned of the biological adverse health effects on human, animal and birds of this form of electromagnetic radiation (EMR) (Al-Damegh MA, 2012). While cell phone, radio waves do not have the energy to allow atoms and molecules to be ionized, the recent warnings regarding long-term electromagnetic radiation exposure posed by mobile phones may be more severe considering the propensity towards male germ line degradation (spermesis and sperm ripening) (Oyewopo A *et al.* 2017). The Technical Working Party (TWG) on the health effects of EMFs has carried out a high-quality, more recent epidemiological animal study.

FSH is shaped and spread from the pituitary gland to performance mainly on Sertoli cells. The effect of FSH on young and mature animals is completely different. FSH is often seen as a pubertal hormone, where high levels of FSH act as a catalyst for testicular growth, form connections between neighboring Sertoli cells, and generally starts sperm formation and expand sperm tubes (Santi D *et al.* 2020)

Once this happens, the Sertoli cell shifts its response from FSH to testosterone as many of the functions regulated by FSH in the immature animal are taken over by testosterone in adults. In later life, both FSH and testosterone stimulate Sertoli cells to take care of Sperm B as it evolves into sperm (Oyewopo A et al. 2017).

Received: May 2019
Accepted: January 2020
Printed: March 2020

Testosterone (T) and its metabolite, 5a-dihydrotestosterone, Regulates energy metabolism, nitrogen retention and muscle growth Maintenance, fat formation, and male modification Reproductive and sexual function (Bird BM and Zilioli S, 2020).

The study aims to measure the effects of electromagnetic radiation for 1/2 hour, 1 hour and 1 hour exposure to changes in the estimation of progesterone hormones in the rat for 14 days and to determine the histological effects of electromagnetic radiation on fertility.

MATERIALS AND METHODS

Two of the radiation sources used in the first research are the base station for a mobile phone in the city of Hilla, in Babil Governorate, in central Iraq, and the second is a microwave oven in the laboratory of the Department of Horticulture and Gardens in the college. Agriculture at the Green Qassim University.

This study included thirty weighted mature rats (190 ± 20 g), age 8-12 weeks. The animals were obtained from the animal house of the Department of Chemistry / College of Science / University of Babylon. They were placed in individual plastic cages and five rats for each cage and for each metal cage equipped with a metal clamp and a bottle for water and a place to put food. Place and cages before starting the experiment. Under standard laboratory conditions (12 hours of light: 12 hours of dark light cycle and relative humidity (25-35) %.

Sham-exposed group (G1): -

This subgroup of the sham-exposed group included ten males that were placed inside a large plastic box lined with aluminum foil and covered with an iron clip to prevent a large amount of radio radiation from reaching the animals and then compare them with other groups such as (pure group).

Exposure range: -

It is divided into four subgroups according to the radiation sources and they include:

A- Animals subject to base station radiation (G2)

These animals were left to adapt for a week, and then constantly exposed to the radiological effects of the mobile phone base station in the city of Hilla in the Babil Governorate, central Iraq. Ten males included

B - Animals subject to half-hour phone radiation (G3)

This subgroup includes ten male animals that have been left to adapt for a week, after which they were exposed daily to radiation from mobile for 1/2 h/day from Samsung Note 9 for 14 days.

C- Animals subjected to phone radiation for 1 hour (G4)

These animals were allowed to adapt for a week, and then for 1 h/ day, they were exposed to the radiological effects of the mobile phone from Samsung's Note 9 for 14 days in the city of Hilla in the Babil Governorate, central Iraq. Ten males included.

D- Animals subject to phone radiation for 2 hours (G5)

These animals were allowed to adapt for a week, and then were exposed to the radioactive effects of the mobile phone from Samsung Note 9 for 2 h/day for14 days in the city of Hilla in the province of Babylon, central Iraq. Ten males included.

SAMPLE COLLECTION

Blood Collection

The animals were anesthetized and then dissected, and blood samples were collected from the heart using a 5 mm syringe, collected in non-clotting tubes and allowed to clot. The serum was separated from the thrombus by centrifugation at 3000 rpm for 10 minutes. The serum was collected in clean tubes and stored at -18 °C for biochemical test.

Histological Study of Organ Samples

All animals were sacrificed, and organs were prepared for tissue microscopy. The testicular tissue sections were prepared for examination and fixed in formalin at 10%.

RESULTS

The sex hormones included testosterone follicle stimulating hormone (FSH) and. The procedure was performed by an enzyme-linked immunosorbent assay (ELIZA). ELIZA device measurement both hormones, according to the procedure modified by (Tietz, 1995) and (Uotila et al. 1981). The results indicated a significant growth in the amount of FSH in the exposure group to the radiation issued from the base of electromagnetic radiation (G2) (1.05 ± 0.09) mlU/ml as well as in the radiation exposure group for 2 hours (G5) (1.32 ± 0.16) mlU/ml compared to the radiation protected group (2.25 ± 0.16mlU/ml) at ($p \leq 0.05$) as shown in **Table 1**. . In the same table, the results also found that the amount of FSH in the third group G3 exposed to radiation emitted by the mobile and for half an hour was greater than the value of the first group G1 as well as the group exposed to mobile radiation for an hour as noted by the ELIZA device.

EMF mobile phones are created when used, thus increasing electromagnetic pollution, known as "electrosmog". The EMF cellular goal remains controversial. Our results are also consistent with the results of (Saygin M et al., 2011), indicating weak testicular tissue due to the primary effect of electromagnetic radiation. Limiting Leydig cells can limit the harmful effect of the magnetic field on Leydig cells, and sperm formation stages can be measured using Johnsen order.

Table 1. Determination of FSH Hormone in Rats Exposed to EMR Compared to Sham-Exposed.

Treatment Groups	FSH (mIU/ml) Mean ±S. E.	Sig.	95% Confidence Interval	
			Lower	Upper
G1	2.25 ± 0.16	0.000	1.89000	2.57000
G2	1.05 ± 0.09	0.000	0.86000	1.21975
G3	2.56 ± 0.14	0.000	2.27000	2.85000
G4	2.16 ± 0.18	0.000	1.83000	2.52000
G5	1.32 ± 0.16	0.000	1.03000	1.66975

Table 2. Determination of Testosterone Hormone in Rats Exposed to EMR Compared to Sham-Exposed.

Treatment Groups	Testosterone (mIU/ml) Mean ±S. E.	Sig.	95% Confidence Interval	
			Lower	Upper
G1	4.932 ± 0.16	0.000	4.5506	5.3134
G2	6.662 ± 0.122	0.000	6.3600	6.9640
G3	3.006 ± 0.11	0.000	2.7310	3.2810
G4	2.953 ± 0.21	0.000	2.4421	3.4639
G5	4.024 ± 0.63	0.000	2.5519	5.4961

This result was agreed with (Bediz et al. 2006) found her in the neutering of 12-day exposed EMF animals, noticeable improvements, and severe changes. Long-term low-frequency exposure to the brain and other body organs has shown EMR to increase peroxide fat, and the results are partly consistent with the results of other studies Zakka et al. 2006. Such findings involve the risk of programmed cell sperm cell killing in mice due to constant frequency application to EMRs at 60 Hz (Kim et al., 2009).

The study carried out by Falzone et al. 2010 . found that the continued exposure of very low frequency semen cells in rats to electromagnetic fields. No major effect on body weight and testicular organs was found.

The results of the experiment showed that there is non significant effect of EMR on the level of testosterone hormone in treatment's group, base station exposure first generation group G2 (6.662 ± 0.122 ng/ml) comparing with G1 sham-exposed group (4.932 ± 0.16ng/ml) (3.223 ± 0.60 ng/ml) , G3 and G4 exposure group (3.006 ± 0.11ng/ml) and (2.953 ± 0.21 ng/ml) lower when comparing with G1 sham-exposed group (**Table2**).

DISCUSSION

The results of this study showed changes in testosterone levels in rats that showed a significant decrease (P <0.05) in radiation-exposed male groups compared to the radiation-protected group.

Lin YY et al., 2018, showed that cells within the testicle, also known as Leydig cells, have an important regulatory function which is the secretion of testosterone that is important in reproduction and the resulting support for spermatogenesis. Thus Leydig cells can be the target of study and finding the negative effects of RF-EMR from cell phone use on reproduction.

EFFECTS OF EMR ON TISSUES

Microscopic examination of the tissues of the first group of laboratory rats in **Figure 1** shows the tissues of the protected group that were not exposed to electromagnetic radiation and were protected from it for 14 days that the cells are normal throughout the testicle, and **Figure 2** group exposed to the electromagnetic radiation from the base of the electromagnetic radiation for 14 days. **Figure 3** A group that was exposed to electromagnetic radiation from the mobile device for half an hour a day and for fourteen days. Natural boundaries throughout the testicle, where the testicle contains a capsule and there were barriers, and all sperm tubes were within the normal range, and the formation of sperm was normal Notably, it contains a peripherally organized sperm, mature sperm in the cavity, and dense connective tissues surrounded by tubes extending from its parts, to separate these tubes.

As for the EMF exposure group for half an hour daily for fourteen days, the diameter of the sperm tubes was compared with the control group and we found no significant relationship (p> 0.05). The percentage of interstitial tissue in the entire testic parenchyma was reduced, as it was statistically significant in groups exposed to EMF, either from the mobile or from the base of electromagnetic radiation in contrast to the control group (p <0.05; **Table 2**, **Figures 2 and 3**).

Activated cells, nuclear cells, and nuclei did not differ significantly between electromagnetic fields and control groups (p> 0.05). However, by applying the degree of testicular biopsy of Johnsen, the estimation of spermatogenesis showed a statistically significant difference between EMF and control groups (p <0.05).

In the exposure group of the electromagnetic field, microscopic examination in **Figure 3** showed the tissue of rats exposed to the magnetic field issued by the electromagnetic radiation station. **Figure 5** represents the tissue of the rats after exposure for two hours to the magnetic field daily and for a period of two weeks some changes in tissues such as sperm tube syncope, with lower animal formation Sperm and interstitial fibrosis diffuse compared to the control group in addition to the absence of mature sperm in the tube cavity.

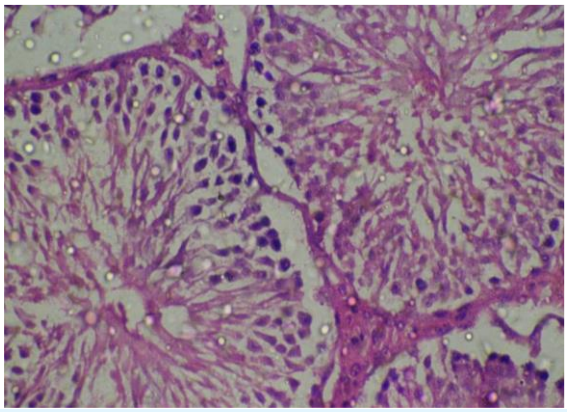

Fig. 1. Leydig cells in tissue related to the murine seminal tubules of the control group (H&E).

Fig. 2. Leydig cells in mouse tissue for a an electromagnetic field exposure group (EMF) for half hour. The test has normal limits (H&E) 100x.

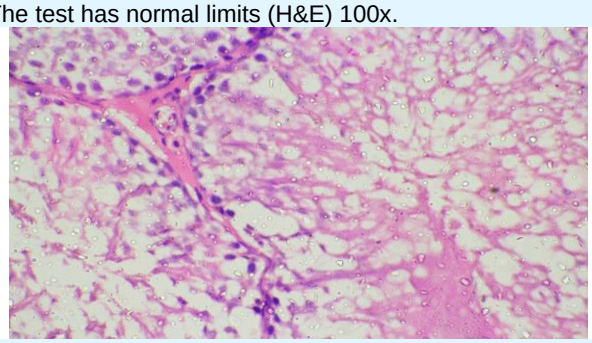

Fig. 3. Leydig cells from mouse tissue with an electromagnetic field exposure group (EMF) from the base, showing diffuse cellular fibrosis barrier, leave as well as suppression of spermatogenesis, (H&E) 400x.

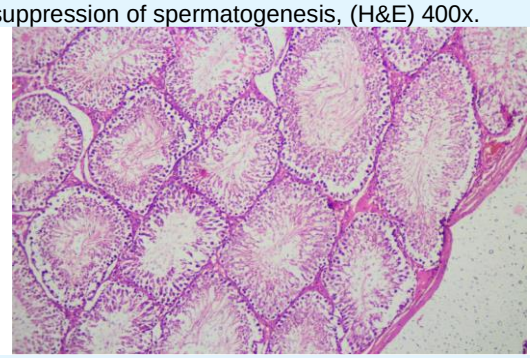

Fig. 4. Leydig cells from mice tissue subjected to one hour with an electromagnetic field exposure group (EMF), the test has normal limits, (H&E) 100x.

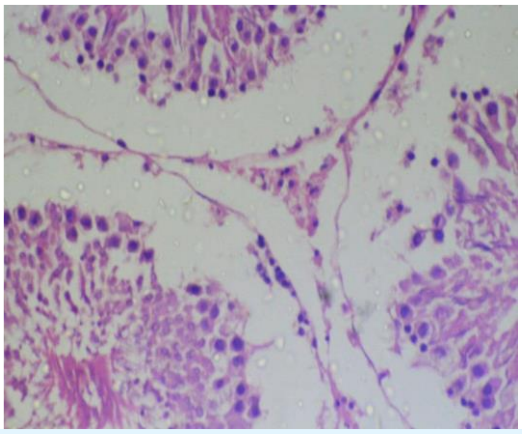

Fig. 5. Leydig cells from mouse tissue with an electromagnetic field exposure group (EMF) for two hours (400x, hematoxylin-eosin [H&E]). The amount of Leydig cells decreased compared to the control group

Microscopy showed some histological changes in the exposure group such as the recess. On examination, it was found that there was an imbalance in the sperm with interstitial edema, the spread of sperm and the deviant barriers compared to the control group.

The results of this study indicate that there is an effect in histology when comparing the exposure group of the radiation station with the protected groups of radiation, which ranges from EMR to testicular tissues in the exposure group in two hours.

CONCLUSION

The use of mobile phones in abundance leads to the generation of electromagnetic radiation and thus environmental pollution. It has been observed that using the mobile phone for two hours a day for a period of 14 days or exposure to radiation generated from electromagnetic radiation stations and for the same period, this affects the male hormones of laboratory rats.

The testicle cells are affected by electromagnetic radiation, as well as the production of sperms in groups exposed to radiation compared to protected groups, which are considered as a control group.

REFERENCES

Al-Damegh MA (2012) Rat testicular impairment induced by electromagnetic radiation from a conventional cellular telephone and the protective effects of the antioxidants vitamins C and E', Clinics 67(7), pp. 785–792.

Al-dulamey QK, Ismail AH, and Al-Jawwady YA (2019) Biophysical Effect of EMR with 5GHz on Male Reproductive System of Mus musclus Mice, Current Journal of Applied Science and Technology, no. April pp. 1–11.

Bediz CS, Baltacy AK, Mogulkoc R and Oztekin E (2006) Zinc supplementation ameliorates electromagnetic field-induced lipid peroxidation in the rat brain. J. Tohoku journal of experimental medicine. 208 (2): pp. 133-140.

Bird BM and Zilioli S (2020) Encyclopedia of Evolutionary Psychological Science, *Encyclopedia of Evolutionary Psychological Science*, (January).

Falzone N, Huyser C, Franken DR, Leszczynski D (2010). Mobile Phone Radiation Dose not Induce Pro-Apoptosis Effect in human Spermatozoo. Radiat. Res., 174,169-176.

Hajiuon B (2014) Effects of Garlic (Allium sativum L.) Hydroalcoholic Extract on Estrogen, Progesterone and Testosterone Levels in Rats Exposed to Cell Phone Radiation. J. ZJRMS. 16 (12): pp. 19-24.

Hemayatkhah JV, Dehghani Kh, Fatahi E, Nazari M and Farzam M (2012) The effects of mobile phone waves on the reproductive physiology in adult female rats. Advances in Environmental Biology. 6(10): pp. 2735-2741.

Kim YW, Kim HS, Lee JS, Kim YJ, Lee SK, Seo JN, Jung KC, Kim N, Gimm YM (2009). Effects of 60 Hz 14 T micromagnetic field on the apotosis of testicular grem cell in mice. Bioelectromagnetics. 30(1), 66-72.

Lin YY, Wu T, Liu JY, et al. (2018) 1950MHz radio frequency electromagnetic radiation inhibits testosterone secretion of mouse leydig cells. International Journal of Environmental Research and Public Health.15(1).

Lin YY, Wu T, Liu JY, Gao P, Li KC, Guo QY, Yuan M, Lang HY, Zeng LH, and Guo GZ (2018) 1950MHz radio frequency electromagnetic radiation inhibits testosterone secretion of mouse leydig cells. International Journal of Environmental Research and Public Health. 15(1).

Maoquan LI, Yanyan W, Yanwen Z, Zhou Z, and Zhengping YU (2008) Elevation ofplasma corticosterone levels and hippocampal glucocorticoid receptor translocation in rats: a potential mechanism for cognition impairment following chronic low-power-density microwave expo- sure. Journal ofRadiation Research 49: 163–170.

Oyewopo A et al. (2017) 'Cell Phone Alters Oxidative Status and Impairs Testicular Function of Male Wistar Rats', pp. 1–5.

Santi D *et al.* (2020) 'Follicle-Stimulating Hormone (FSH) Action on Spermatogenesis: A Focus on Physiological and Therapeutic Roles', *Journal of Clinical Medicine*, 9(4), p. 1014. doi: 10.3390/jcm9041014.

Saygin M, Caliskan S, Karahan N, Koyu A, Gumral N, and Uguz A (2011)"Testicular apoptosis and histopathological changes induced by a 2.45 GHz electromagnetic field," Toxicology and Industrial Health, ,vol. 27, no. 5, pp. 455–463.

Saygin M, Caliskan S, Karahan N, Koyu A, Gumral N, Uguz A (2011) Testicular apoptosis and histopathological changes induced by a 2.45 GHz electromagnetic field. Toxicology and Industrial Health 27(5):455-463.

Vignera La, Condorelli S, Vicari RA, Agata ED, Calogero RAE (2012) Effects of the exposure to mobile phones on male reproduction: A review of the literature. J. Androl 33, 350–356.

Zecca L, Mantegazza C, MargonatoV, Cerretelli P, Caniatti M, Piva F, Dondi D and Hagino N (2006) Biological effects of prolonged exposure to ELF electromagnetic fields in rats: III.50 Hz electromagnetic fields. Bioelectromagnetics 19(1): pp. 57-66.