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**ORIGINAL ARTICLE**

## **Detrimental Effects of Gestational Exposure to 900mhz Electromagnetic Fields Emitted by Cellular Phone on Litter Size and Secondary Sex-ratio in Syrian Hamsters (*Mesocricetus Auratus*)**

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Habib Aghdam Shahryar, Alireza Lotfi, Mohammadreza Valilou, Pouya Faeghi: Detrimental Effects of Gestational Exposure to 900mhz Electromagnetic Fields Emitted by Cellular Phone on Litter Size and Secondary Sex-ratio in Syrian Hamsters (*Mesocricetus Auratus*)

### **ABSTRACT**

Detrimental effects of exposure to electromagnetic fields (EMF) on reproduction and secondary sex-ratio were reported in literatures. The aim of this study was to investigation on hazardous cell phones EMF effects pre- or during pregnancy on litter size and sex-ratio. Ninety two months old Syrian hamsters (45 male and 45 female) with same weight (150-160 g) was provided. Fifteen female hamsters served for each of three experimental groups; group1 or control (without exposure to EMF), group2 (females in exposure to cell phone EMFs 20-day pre-pregnancy) and group3 (females in exposure to cell phone EMFs during pregnancy). The exposures were performed 1 h/d to a 900 MHz EMF emitted by cellular phones at aquarium-like glass cages include cellular phone (Sony Ericsson® K750i, specifics: ON, SAR: 0.66w/kg), covered by aluminum sheet. All of male hamsters for mating with experimental females were kept far of any stress and EMF. After littering, litter size and sex-ratio of weaned litters were determined. Group3 had significant lowest litter size (14, 15 and 9 respectively for group1, 2 and 3) and secondary sex-ratio in comparison with control and group2 (74.7, 56.7 and 34.2% respectively for group1, 2 and 3). Regardless to similarity between groups for weaning ratio of litters, maternal exposure to 900 MHz EMF especially during pregnancy had negative effects on litter size and their sex-ratio. Sex-ratio skewing to female was observed in both exposed groups (pre- or during pregnancy). It is concluded, gestational exposure to 900 MHz EMF (cellular phones EMF) may reduce litter size and secondary sex ratio in hamsters, but pre-gestational exposing cannot.

**Key words:** Cellular phone, electromagnetic fields, radiation, sex ratio, Syrian hamster.

### **Introduction**

with extension and progress in electronic and telecommunication industries In recent decades, organisms are in exposure to harmful bio-effects of electric, magnetic or electromagnetic fields (EMF), that their detrimental effects on organics specially in near of fields are documented [5]. Recent various studies have suggested that the exposure to extremely

low frequency (ELF) magnetic fields (MF) affect mammalian health include liver function [15], cell proliferation [9], hematopoietic parameters [4,22], oxidative stability [12], lipid and glucose metabolism [18,19,20].

Also hazardous effects of 900 MHz EMF emitted by cellular phones on endocrine system and reproductive performance were reported in literatures and our past studies [1,2].

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Exposure to radiofrequencies caused skewing secondary sex-ratio to female; In Zadeh and Briggs [25] study, the radiologists and surgery technicians that are in exposure to ionizing radiation commonly had more daughters. In during 1980- 2000, secondary sex-ratio of Greek workers at industrial factories with radiation generating machines is skewed to female [10].

About reproductive effects in laboratory mammalian models, gestational exposure to 2450-MHz microwaves had thermal effect on reproductive organs of hamster [8]. Irradiation of the mouse embryo can lead to various effects (lethality, growth retardation, congenital abnormalities), depending on the period of gestation at which irradiation occurs [16]. Bellossi [6] reported that gestational exposing to 460 MHz MF (30 min/ day and 2day/week to end of pregnancy) caused considerable high mortality for mice litters. In this line, declining of fertility in exposure to 50 Hz MF [3], malformations of litters [24], increased number of fetuses with skeletal anomalies [14] and greater placental resorptions in gestational exposure to MF were reported [11] in rodent. But some studies such as Buschmann and Bornkessel [8], the high frequency EMF gestational exposure at 900 MHz hadn't considerable teratogenic, embryo-lethal or retarding effects in rat. Because of global concerns of cellular phone application during pregnancy and relative scientific debates, aim of this study was to determination of hazardous effects of exposure to cell phones EMF at pre- or during pregnancy on litter size and sex-ratio as important reproductive traits.

**Material and methods**

*-Animals and Exposing Condition:*

In present experiment, ninety two months -old Syrian hamsters (45 male and 45 female) with same weight (150-160 g) was provided. Fifteen female hamsters served for each of three experimental groups; group1 or control (without exposure to EMF),

group2 (females in exposure to cell phone EMFs 20-day pre-pregnancy) and group3 (females in exposure to cell phone EMFs during pregnancy). The exposures were performed one hour/day to a 900 MHz EMF emitted by cellular phones at aquarium-like glass cages include cellular phone (Sony Ericsson® K750i, specifics: ON, SAR: 0.66w/kg), covered by aluminum sheet. They were acclimated for 1 week prior to use, maintained on 12h light:12h dark cycle in a temperature-regulated (22-23°C ) animal room with a continue free access to water and food. The animal studies were carried out in adherence to the guidelines established in the "Guide for the care and use of Laboratory Animals, US Department of Health and Human Resources (NIH1985)".

In this experiment, hamsters were in condition similar to pet housing systems. All of male hamsters for mating with experimental females were kept far of any stress and EMF. After littering, litter size and sex-ratio (male/ female) of weaned litters were determined for three experimental groups.

*- Statistical Analysis:*

Obtained data for litter size and sex-ratio traits were analyzed by SAS software ver. 9.1 and significant differences between groups were detected via Duncan multiple range test.

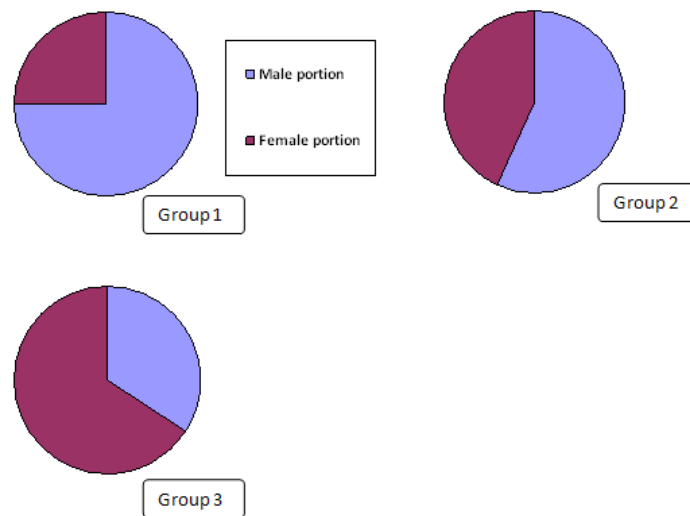
*Results:*

With attention to table1, group3 had significant lowest litter size (14,15 and 9 respectively for group 1, and 3) and secondary sex-ratio in comparison with control and group2 (74.7,56.7 and 34.2% respectively for group1, 2 and 3). Regardless to similarity between groups for weaning ratio of litters, maternal exposure to 900 MHz EMF especially during pregnancy had negative effects on litter size and sex-ratio (table1 and figure1). Sex-ratio skewing to female was observed in both exposed groups (pre- or during pregnancy) [figure1].

**Table 1:** Mean litter size, weaned litter percent and secondary sex ratio of female hamsters in gestational exposure to 900 MHz EMF emitted by cellular phone.

Experimental groups	Maternal exposing specify (frequency and duration)	Litter size	Weaned litters		Sex-ratio (male/female) %
			No.	%	
1: control	Without exposure to EMF	14a	11a	81.5	74.7a
2: pre-gestation	900 MHz cell phone EMF (1 h/d, 20 d pre-pregnancy)	15a	11a	74.2	56.7a
3: during gestation	900 MHz cell phone EMF (1 h/d, during pregnancy)	9b	6b	63.8	34.16b
P value		0.01	0.01	0.58	< 0.01
SEM		0.92	1.04	11.68	5.58

•Different letters (a or b) show significant differences between groups.



**Fig. 1:** Diagram of offspring sex-ratio for experimental groups in pre-gestation or gestational exposure to 900 MHz EMF emitted by cellular phone.

#### Discussion:

In a research, Takahashi *et al* [23] follow an experiment with gestational exposure to 2.14 GHz (similar with frequency of mobile telecommunication base station) reported that this exposure condition hadn't any considerable effects for growth, gestational condition and organ weights for dams and survival rates, development, growth, physical and functional development, hormonal status, memory function and reproductive ability of the F1 offspring (at 10 weeks of age) along with embryotoxicity and teratogenicity in the F2 rats. But this work [23] didn't discuss about sex ratio or litter size. But in other hand, Hassa *et al.*, [13] reported that gestational exposure to EMF with frequency of 50 Hz may alter the normal development of the skeletal systems of rat fetuses. Also, Al-Akhras *et al.*, [3] show that pre-gestational exposure to extremely low frequency of MF (50 Hz, 90 days) can reduce fertility, mean number of implantations and living fetuses. Present results about litter size for gestational exposing group (n: 9) is significantly ( $p < 0.01$ ) smaller than control or pre-gestational exposing. Thus, present finding about pre-gestational exposure to extremely low frequency of EMF (900 MHz) [table1] were opposite to Al-Akhras *et al.*, [3] and for gestational exposure is in agreement with Hassa *et al.*, [13] and opposite to Buschmann and Bornkessel [8]. Differences between present results and Buschmann and Bornkessel [8] for gestational exposure to 900 MHz EMF may be depend on exposing condition; in present experiment, direct cellular phones EMF was used, not any analogue. It seems that gestational exposure to cellular phones EMF can have lethal effects on hamster fetuses and lowers litter size. Buschmann and Bornkessel [8] didn't discuss about sex ratio and

litter size, because of this, comparison of parameters between two works are limited.

About rodent secondary sex ratio, environmental conditions such as temperatures at conception and gestation period can cause declined secondary sex ratio [21]. The natural sex-ratio in rodent is more than 50% (more male litters) and it is variable via season, maternal age and gestation time and paternal reproductive characterizes such as endocrine and sexual activity (such as sperm ejection number) and is not always %50 [26]. Secondary sex ratio in present experiment is according to normal ranges [26] for group 1 and 2, but EMF exposure during pregnancy had significant negative effect on sex ratio (group3: 34.16) and it was considerable lower than normal rate [figure1].

Past researches in relation to EMF effects on sex ratio commonly were conducted on human; Larsen *et al.*, [17] reported that sex ratio of children born by highly EMF exposed mothers is only 23.5%. In present study we had recorded 34.16% secondary sex ratio for gestational exposed hamsters [table1 and figure 1] that is in agreement with Larsen *et al.*, [17] findings for EMF exposed physiotherapists. It is concluded, gestational exposure to 900 MHz EMF (cellular phones EMF) may reduce litter size and secondary sex ratio in hamsters, but pre-gestational exposing cannot alter litter size or sex-ratio. In overall exposing to cellphones EMF can be hazardous during gestation.

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