EFFECTS OF RADIOFREQUENCY RADIATION FROM WIFI DEVICES ON HUMAN EJACULATED SEMEN

Olatunde Michael Oni [1*], Dauda Biodun Amuda [1] & Celestine Etumonu Gilbert [2]

[1]Department of Pure and Applied Physics
Ladoke Akintola University of Technology, Ogbomoso, Nigeria
[2]University Health Centre
Ladoke Akintola University of Technology, Ogbomoso, Nigeria
***E-mail:** olatundeoni@yahoo.com; omoni@lautech.edu.ng, Phone no: +2348036886236

ABSTRACT

This is an *in-vitro* pilot study which established the effect of radiofrequency radiation (RFR) from 2.4 GHz laptop antenna on human semen. Ten samples of the semen, collected from donors between the ages of 20 and 30 years were exposed when the source of the RFR was in active mode. Sequel to the exposure, both the exposed samples and another ten unexposed samples from same donors were analysed for sperm concentration, motility and morphology grading. A test of significance between results of these semen parameters using Mann-Whitney U- test at 0.05 level of significance showed a significant effect of RFR exposure on the semen parameters considered.

Keywords: *Radiofrequency radiation exposure; sperm parameters; wifi devices; laptop antenna*

1. INTRODUCTION

Radiofrequency radiation (RFR) is field forming part of the electromagnetic spectrum. This term is used for fields within the frequency range of 10 MHz and 300 GHz. Many sources, both natural and man-made generate RF fields of different frequency. Commonly used sources of RFR include FM radio and TV transmitters and antennas, microwave ovens, radar, satellite links, wireless communication transceivers and sun [1].

The use of mobile telecommunication services in the last decade has drastically increased the amount of radiofrequency radiation exposure in our daily lives. Mobile telephones, sometimes called cellular phones or GSM (Global System of Mobile Communication) are now integral part of modern telecommunications. In addition to GSM, wireless local area network of wireless fidelity (wifi) devices , operating at 2.4 GHz are an increasingly common technology employing radiofrequency energy for communication.

Communication devices using wifi technology are low cost and operate in the unlicensed spectrum at 2.40 – 2.48 GHz, popularly called the industrial, scientific and medical (ISM) band of 2.4 – 2.5 GHz in many part of the world. The low cost and easy-to-deploy nature of wifi access points (APs) and clients (users) infrastructures are identifiable reasons of popularity of wifi devices for communication purpose, mostly via the internet. A recent release by a commercial firm reported that there are presently more than 100,000 wireless local area network (WLAN) "hotspots" in operation around the world. Almost all the WLANs reported are based on the IEEE 802.11 standards or one of its amendments [2, 3, 4].

While WLANs operate at low power, Foster [5] reported that little quantitative information is available to the public or to health physicists and other professionals about the levels of exposure that they produce to the public. Very few technical reports on the potential harmful effects of RFR still remain controversial. However, more health concerns are raised recently. These concerns are not unconnected to the fact that wifi devices are placed in close contact with the body when in use. A typical example is laptop, usually placed on the laps, a distance of few centimeters to the gonads; thus raising curiosity on the effect of radiofrequency exposure from this wifi device on spermatozoans produced by the gonads.

Recent epidemiologic studies [6, 7, 8, 9, 10] have highlighted the role of exposure of RF at 900 MHz on sperm motility, morphology and viability. Despite the results of the studies, indicating a decrease in fertility due to RF exposure on semen parameters, it is imperative to conduct a scientifically robust study involving use of people who are not using and have never used RF devices in the past, as control group. However, selection of such control groups is extremely difficult; thus making a study involving *in-vivo* human exposure not feasible.

The World Health Organisation's (WHO) recent research agenda [11] for studies on RF suggests that *in- vitro* studies play a supporting role in health risk assessment and are critical to the optimal design of animal and epidemiology studies. Sequel to this, an *in- vitro* pilot study of effects of radiation from cellular phones on human semen had been undertaken by Agarwal *et al* [12]. In that study, just like other related ones [13,14], radiofrequency electromagnetic waves emitted from cell phones had been reported to lead to oxidative stress in human semen. The

study further asserted that keeping the cell phone in trouser pocket in talking mode may negatively affect spermatozoa and impair male fertility.

The possibility of RFR from cell phones having negative effects on spermatozoa motivated this current study. The goal of this study was to establish the effect of a commonly used RF source for communication in the 2.4 GHz frequency (laptop) on human semen parameters when such communication device, in an active mode is placed in close proximity to the male reproductive organs.

2. MATERIALS AND METHODS

2.1 The RF source

An access point (AP), consisting of a portable radio (a 2.4 GHz picostation by Ubiquity Networks, USA, with its integrated omnidirectional antenna was set up for internet broadcast via wireless at 2.4 GHz. A laptop usually placed at a distance of less than 60 cm from the human thigh (lap) was configured to serve as the wireless client accessing the internet broadcast signal.

The AP-client arrangement was configured and left in this active mode. The traffic over this arrangement was monitored by AirView spectrum analyzer 1.0.11, a 2.4 GHz spectrum analyzing software by Ubiquity Networks, USA.

2.2 Sample Collection, Preparation and Exposure

Semen samples were collected from 10 donors having ensured abstinence period of 48-72 hours, to ensure sufficient volume and quality of the semen samples. The ejaculated semen samples were allowed to liquefy completely for 15-30 min at 37 ^{o}C [12]. Subsequent to liquefaction, each sample was divided into two aliquots: control (unexposed to RFR) and the exposed.

One aliquot of the samples from each of the donors was exposed to the RFR emitted from a laptop (HP G50 series) while in active mode of sending and receiving packets to and fro of the access point serving as gateway to the internet. The distance between the laptop antenna and each of the sample was kept at 60 cm. The duration of exposure was 1 hour. Unexposed (control) aliquots were kept under identical conditions but without RFR exposure (Baste et al, 2008).

2.3 Laboratory and Statistical Analyses

Immediately after exposure to RFR radiation, both aliquots (control and exposed) were analysed for sperm concentration, motility and morphology grading according to WHO guidelines [15]. Comparison of all parameters between the exposed and the unexposed groups was done using non – parametric Mann-Whitney U test. The statistical analysis was done using statistical package for social sciences (SPSS) version 15. The probability, P values less than the chosen level of significance α , were considered to be significant.

3. RESULTS AND DISCUSSION

The mean of the sperm concentration and other parameters for both exposed and unexposed semen are presented in table 1. There was no significant difference noticed in sperm concentration between exposed and unexposed samples.

Table 1. Result of semen parametric analysis and statistical values

	Microscopy Count (x 10^6 Cell/L)	Motility grading (%)								Morphology grading (%)							
	Conc.	Rapid progressive		Slow progressive		Non-progressive		Dead sperm cell		Normal spermatozoa		Head defect		Tail defect		Middle piece defect	
Group	Exp UNE	Exp	UNE	Exp	UNE	Exp	UNE	Exp	UNE	Exp	UNE	Exp	UNE	Exp	NE	Exp	UNE
mean	16.04 20.57	64.00	76.00	20.00	10.00	10.00	5.00	7.50	5.00	50.00	55.00	10.00	10.00	24.00	16.00	14.00	21.00
S.D.	4.234 5.395	6.992	5.164	0.000	0.000	0.000	0.000	2.635	0.000	0.000	5.271	0.000	0.000	5.164	5.164	5.163	7.379
n	10	10		10		10		10		10		10		10		10	
p(2tail)	0.19	0.001		0.000		0.000		0.012		0.012		1.000		0.006		0.032	
p(1tail)	0.19	0.002		0.000		0.000		0.063		0.063		1.000		0.015		0.052	

Note: S.D. = standard deviation; Exp = exposed; UNE = unexposed

The semen parameters describing sperm motility were found to be significantly different in exposed samples relative to the unexposed samples. However, at the 1 –tail probability level, dead sperm cell was not significantly different between exposed and unexposed samples.

Analysis of the morphology grading of the semen samples showed that exposure to RFR had no significant effect on the head defect of the samples. All other parameters (normal spermatozoa, tail defect and middle piece defect) considered revealed that RFR exposure had significant effect on them. The analyses were performed at the level of significant (α) equals 0.05.

4. CONCLUSION

The *in-vitro* pilot study of the effect of 2.4 GHz RFR exposure on human ejaculated semen had been conducted. Sperm concentration, motility and morphology grading of the semen were found to be affected significantly by exposure to RFR emanating from a laptop antenna in active mode at 2.4 GHz frequency. Being a pilot study, the results of this work can serve as a reference to further researches, most especially as wireless communication is most adopted worldwide and among the reproductive group. Also, this work creates awareness of the possible alteration by RFR at 2.4 GHz on semen analysis result if such is conducted in the vicinity of the source of the RFR.

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