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Long Term Effect of Electromagnetic Radiation from GSM Masks on Physiological Parameters in West African Dwarf Buck-Kids

Fatoba T. A.
Department of Animal Production and Health,
Olusegun Agagu University of Science and Technology, Okitipupa, Ondo State, Nigeria. E-mail: ta.fatoba@oaustech.edu.ng

Diduyemi M. O
Department of Chemical Sciences
Olusegun Agagu University of Science and Technology, Okitipupa, Ondo State

ABSTRACT

Human exposure to electromagnetic fields (EMF) emanated from many different sources and occurs in various situations in everyday life need urgent public awareness over their potential detrimental human health effects. This study examined the effect of the base station Glo mask (≈1800MHz; 66.6W) on physiological parameters using West African Dwarf (WAD) buck kids. Twelve (12) bucks aged 4 months were randomly grouped into four treatments groups {Group I (<5m), Group II (75m), Group III (150m) and Group IV (>250m)} with three (3) buck-kids per group based on their proximity to the masks station using completely randomized design (CRD) for this study. Each buck was examined for physiological parameters using standard procedure. The results revealed that animals in the group I had distortion in the gonadal development and delayed sexual development effect ($p<0.05$) than other treatments. In conclusion, the electromagnetic radiation (EMR) from base station affects some physiological parameters in West African Dwarf (WAD) Buck- kids. The findings support the administration of antioxidants to occupant of a residential building living close to the base station masks.

Keywords: Buck-kids, electromagnetic radiation (EMR), base station masks, reproductive

INTRODUCTION

Use of wireless mobile phone in recent times are necessitated the need for telephone base stations to meet the desire of network providers demands of the increasing

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population of telephone users. EMF induces electric fields thereby competes with endogenous current and voltages, thus disturbing normal physiological balance (Loscher and Kas, 1998), human fertility (La Vignera et al. 2012) also increased the production of reactive oxygen species (ROS), including superoxide anion, hydrogen peroxide and hydroxyl radicals (Aweda et al. 2003). Oksay et al (2014) reported that ROS promotes lipid peroxidation, and thus modify the antioxidant protection systems which may disturb ROS metabolism by enhancing the production of ROS or by decreasing the activity of antioxidant enzymes in human tissue and contributing to oxidative stress (Ozguner et al. 2005) with the current global concern for the potential health hazard induced by electromagnetic radiation (EMR).

Several workers reported the adverse effects of radiofrequency electromagnetic fields (RF-EMF) exposure in modulating normal physiological function especially the brain (Narayanan et al. 2009, Fragopoulou et al. 2010, Ammari et al. 2008 and Nittby et al. 2008) and inhibits Melatonin (N-acetyl-5-methoxy-tryptamine) which is primarily synthesized by the pineal gland, considered a potent antioxidant and detoxifies a number of ROS in many pathophysiological conditions (Pieri and Marcheselli 1994, Ekmekcioglu 2006, Azab and Ebrahim 2017) could lead to harmful effects on reproductive patterns. Efforts must be made to minimize contact with radiations and antioxidants must be administered regularly to counteract the effects brought about by radiations. activity of the pineal gland in several animal species just like light (Rodriguez et al., 2004, Cucurachi et al., 2013). Melatonin regulates the pulse of gonadotropin releasing hormones in the hypothalamus, influencing follicle stimulating hormone (FSH) and luteinizing hormone (LH) (Wang et al., 2003; Al-Akhras et al., 2006). Eventually, this can alter the production of gonadal sex steroids, resulting in changes in spermatogenesis and masculinization (Mollerlokken and Moen 2008; Sepehrimanesh et al. 2014; Oksay et al. 2014). Sexual maturity marked the age at which the male attains full reproductive capacity after puberty. However, attention was paid to examine the effect imposed on male sperm productions that are constantly exposed to EMR in the area. Therefore, a study on the effect of RF-EMR from telecommunications on spermatogenesis using West African Dwarf buck-kids is therefore demand attention.

MATERIALS AND METHOD

Experimental Design

Twelve (12) healthy West African Dwarf (WAD) buck-kids aged 4 months with the same genetic background and within their home range were used for this study at Olusegun Agagu University of Science and Technology, Okitipupa Main Campus

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Ondo State, Nigeria. They were randomly station at different position proximity to the GLO masks station. The bucks were sample into four (4) groups, Group I (negative control) (5m), Group II (75m), Group III (150m) and Group IV (250m) (positive control) comprising three (3) bucks per group. The experimental period lasted for 4 months until bucks reached sexual maturity.

Determination of physiological parameters

The bodyweights of the animals were taken every week with Saulter hanging scale with an accuracy of ± 0.01kg (Saulter type, E1200). The clinical thermometer was inserted into the rectum 3.5-4.0cm for 1 minute and the reading taken for the rectal temperature and on the scrotal sac to take testicular temperature Pulse rate, heart rate and respiratory count rate were determined according to the method described by Fatoba et al (2012).

Semen collection and analysis

Semen was collected through the electro-ejaculator into collecting tube while semen evaluation was done according to Karagiannidis et al (2000) and Oyeyemi et al (2001) procedures. The color of the semen was determined by visual evaluation. Mass activity was determined within one minute of collection by a drop of concentrated semen without a slip under low magnification (x4). The semen was placed in a buffer solution for further analysis.

Statistical Analysis

Data generated were analyzed using One-way ANOVA followed by the Duncan ‘s Multiple Range Test using SPSS version 23.

RESULTS AND DISCUSSION

Exposure effect of electromagnetic radiation on the physiological parameters from 75m from the base station led to an increase in the bodyweight, heart rate, pulse rate, respiratory count rate and rectal temperature in West African dwarf buck-kids (Table 1). It was observed a distant-dependent relation and statistically significant ($p<0.05$) reduction in ambient, testis and fur temperature of buck-kids exposed to EMR at a distance >75m from the base station. The observed decreased in hear rate was corroborated by Misek et al (2000) as increased in heart rate variability parameters associated with lower heart rate indicating increased cardiac vagal control under the exposure to radiofrequency electromagnetic field (RF EMF) in experimental methods. Decrease in respiratory could be attributed to oxidative stress resulted from

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lipid peroxidation, and thus modify the antioxidant protection systems ((Ozguner et al. 2005; Oksay et al 2014) thereby induced by electromagnetic radiation (EMR).

Table 1: Effect of electromagnetic radiation on the physiological parameters of West African dwarf buck-kids

Parameter	Control [A]	75m [B]	150m [C]	250m [D]	SE
Bodyweight (Kg)	6.47	7.35	7.56	7.69	0.7138
Heart rate (beats/minute)	64.46^{b}	67.38^{a}	66.72^{a}	66.45^{a}	0.1732
Respiratory count rate (beats/minute)	52.63^{b}	56.45^{a}	56.78^{a}	57.32^{a}	0.3614
Heat stress Index	1.22	1.19	1.17	1.14	0.0725
Rectal temperature ^{O}C	38.75	39.50	39.73	39.50	0.2153
Ambient temperature ^{O}C	34.33	32.43	32.33	31.67	0.1483
Fur temperature ^{O}C	29.23	28.33	28.53	28.50	0.2043
Teste temperature ^{O}C	36.21^{a}	34.50^{b}	34.67^{b}	33.57^{b}	0.0136
Skin temperature ^{O}C	35.76	36.83	36.75	36.50	0.2417

a,b, values along the same row with different superscripts are significant (p)

S.E = Standard error which may disturb ROS metabolism by enhancing the production of ROS or by decreasing the activity of antioxidant enzymes in human tissue and contributing to oxidative stress (Ozguner et al. 2005) with the current global concern for the potential health hazard induced by electromagnetic radiation (EMR).

The results of this study showed that Emr exposure affects spermatogenesis in WAD buck-kids as shown in Table 2. At four months old none of the buck-kids examined had spermatozoa in the ejaculate, which microscopically has an appearance of clear semen. At six months, 0%, 50%, 50% and 50% buck-kids showed motile spermatozoa in the ejaculate for A, B, C and D respectively, with percentage of motility of 0 %, 50%, 50% and 50%. With advancement in age, buck-kids at B, C and D at seven months showed increase in the number of buck-kids that had spermatozoa in the ejaculate except the control (A) group. At 7 months of age, 0 %, 100%, 100% and 100% had spermatozoa in the ejaculate in B, C and D buck-kids respectively. There were differences in the scrotal circumference and sperm characteristics of the buck-kids in this study. The scrotal circumference, mass activity, mass motility and sperm concentration are higher than the control animals. The testicular parameters of the buck-kids showed significant differences ($P<0.05$) and followed the same trend.

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Table 2: Effect of Electromagnetic radiation on onset of puberty in West African Dwarf bucks

Parameter	Control [A]	75m [B]	150m [C]	250m [D]	S.E
Colour	White	White	White	White	-
Mass activity	0^b	2.0^a	2.0^a	2.5^a	1.7326
Mass motility	0^b	43^a	45^a	50^a	3.0045
Sperm conc. (x 10^7)	0^b	5.25^a	5.28^a	5.36^a	0.8765
Sperm abnormality	0^b	64^a	58^a	55^a	2.9649
Unripe sperm (%)	0^b	80^a	65^a	60a	3.2376
Liveability	0^b	80^a	90^a	90^a	1.4431

a,b, values along the same row with different superscripts are significant (p)
S.E = Standard error

The buck-kids placed at distance >75m in this study showed onset of spermatogenesis in the ejaculate at >6 months old than 5m distance buck-kids, the onset of puberty is earlier than Nubian bucks (Chakraborty et al 1989) and in line with reports on African-type goats that reach sexual maturity after the sixth month of age (Webster and Wilson 1989) supported by the reports of Bielli et al (2001) that the breeds of these goats could account for variations in age at puberty. In a male animal, puberty, defined as the age at which spermatozoa appear in the seminiferous tubules, epididymis or ejaculates, is attained over a wide age range depending on the breed (Bielli et al 2001). In the present study, it can be said that puberty was delayed in the group A (control) bucks placed at the base of the mask station which could accounts for the reduction in the scrotal circumference which corroborated with the report of Daramola et al (2007) traits such as testicular size and commencement of spermatogenesis appeared in a more advanced degree in treated bucks as compared to untreated (control) bucks.

The delayed puberty observed in the animals in the control compared with other groups could be explained by a slower growth and radiation effect on this animal in the tropical condition (Delgadillo and Malpaux 1996). Although local goats including WAD goat display interesting reproductive characteristics, most of them could reach puberty at an age of 8 months (Delgaldillo and Malpaux 1996), there exists strong influence of the environment, which does not allow these potentials to be fully expressed. The most likely explanation for the delay in the appearance of spermatozoa is that, though the immature adenohypophysis contains gonadotrophins, these are not released from it in sufficient quantity until puberty to bring about maturation of the gonads (Ahmad and Noakes 1996; Bielli et al 2001). There appeared to be interaction between scrotal circumference as well as testicular size in relation to the appearance of spermatozoa in the ejaculate Testicular weight

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and testicular circumference indicate an acceleration of testicular development at puberty in the B, C and D group animals against the A (control) animals. So the acceleration of testicular development was declined by the Emr exposure suggested that radiation could produce a suppressive effect on the hypothalamus. A negative feedback could have been established that worked for further decrease in testosterone concentration, which in turn reduced the process of spermatogenesis. This observation agrees with report of Daramola et al (2006) that Emr reduces testosterone concentration and sexual behaviours in WAD goat.

The present findings agreed with available reports, which have examined the relationship of testicular measurements with semen characteristics (Notter et al 1985; Sultama and Edey 1985). The high incidence of abnormalities indicates that buck kids normally produces immature spermatozoa at tender age compared to mature animals Although ejaculates from younger rams have been reported to contain a greater number of abnormal cells consisting in the most part of head which indicate incomplete spermatogenic activity and incomplete epididymal maturation (Colas 1983), the results of this study showed that the goat buck-kids are at growing stage

CONCLUSION

A study on the effect of RF-EMR from telecommunications on spermatogenesis using West African Dwarf buck-kids was conducted. Twelve (12) healthy West African Dwarf (WAD) buck-kids aged 4 months with the same genetic background and within their home range were used at Olusegun Agagu University of Science and Technology, Okitipupa Main Campus Ondo State, Nigeria. In conclusion evidence abound that electromagnetic radiations have deleterious effects on the male reproductive system such as increased testicular temperature impeding the process of spermatogenesis, histological aberrations in the testes and sometimes reduction in weight of the testicular tissue. The results of this study showed that Emr exposure delayed spermatogenesis in WAD buck-kids.

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REFERENCES

Ahmad N and Noakes D E (1996). Sexual maturity in British breeds of goat kids. *British Veterinary Journal* 152 (1) 93-103

Al-Akhras, M., Darmani, H., Elbetieha, A. (2006). Influence of 50 Hz magnetic field on sex hormones and other fertility parameters of adult male rats. *Bioelectromagnetics,* 27(2):127-131.

Ammari M, Jacquet A, Lecomte A, Sakly M, Abdelmelek H and de Seze R (2008). Effects of head -only sub chronic and chronic exposure to 900-MHz GSM. *Brain Injury* 22 (13–14):1021–1029.

Aweda, M. A., Gbenebitse, S and Meidinyo, R. O (2003). Effects of 2.45 GHz microwave exposures on the peroxidation status in Wistar rats. *Niger Postgrad Med J* 10(4):243-246

Azab, A. E and Ebrahim, S. A (2017). Exposure to electromagnetic fields induces oxidative stress and pathophysiological changes in the cardiovascular system. *J Appl BiotechnolBioeng* 4(2): 540-545

Bielli, A., Katz, H., Pedrana, G., Gastel, M. T., Morana, A., Castrillejo, A., Lundeheim, N., Forsberg, M and Rodriguez-Martinez, H (2001). Nutritional management during fetal and postnatal life, and the influence on testicular stereology and sertoli cell numbers in corriedale ram lambs. *Small Ruminant Research* 40: 63-71

Chakraborty, P. K; Stuart, L. D and Brown, J. L (1989). Puberty in the male Nubian goat serum concentrations of LH, FSH and testosterone from birth through puberty and semen characteristics at sexual maturity. *Anim. Reprod. Sci*. 2: 91-101.

Cucurachi, S., Tamis, W/ L., Vijver, M. G., Peijnenburg, W. J., Bolte, J. F and de Snoo, G. R (2013). A review of the ecological effects of radiofrequency electromagnetic fields (RF-EMF). *Environ Int* 51:116– 140

Colas, G (1983). Factors affecting the quality of ram semen. In: Haresign W (Editor). Sheep Production. Butterworths, London, pp 453-465

Daramola, J. O; Adeloye, A. A and Soladoye, A. O (2006). Effect of Exogenous Melatonin on sexual behaviours in West African Dwarf goat *Livestock Research for Rural Development* 18(9). http.//www.cipav.org.co//rrd18/9/dara18133.html.

Daramola, J. O., Adeloye, A. A., Fayeye, T. R., Fatoba, T. A., and Soladoye, A. O (2006). Induction of Puberty in West African Dwarf Buck-kids with Exogenous melatonin. *Livestock Research for Rural Development* 19(9).

Delgadillo, J. A and Malpaux, B (1996). Reproduction of goats in the Tropics and sub-tropics. *Proceedings of the VI International Conference on Goat.* Volume 2. 6-11, May 1996, Beijing, China

Ekmekcioglu, C (2006) Melatonin receptors in Humans: Biological role and chemical relevance. *Biomed. Pharmacother* 60 (3): 97-108.

Fatoba, T. A., Adeloye, A. A., and Soladoye, A. O (2012). Physiological Responses of West African Dwarf Buck as affected by *Datura stramonium* Linn Seed Extracts. *Journal of Environmental Issues and Agriculture in Developing Countries* 4(3). 1-4

Fragopoulou, A. F., Miltiadous, P., Stamatakis, A., Stylianopoulou, F and Koussoulakos, S. L (2010) Margaritis. *Pathophysiolog*y (17): 179–187.

Karagiannidis, A; Varsakeli, S; Alexopoulos, C and Amarantidis, I (2000). Seasonal variation in semen characteristics of Chios and Friesian rams in Greece. *Small Ruminant Research.* 37: 125- 130.

La Vignera, S., Condorelli, R. A., Vicar, E., D'Agata, R and Calogero, A. E (2012). Effects of the exposure to mobile phones on male reproduction: a review of the literature. *J.* Andrologia. 33: pp. 350–356.

Loscher, W and Kas, G (1998). Conspicuous behavioural abnormalities in a dairy cow herd near TV and Radio Transmitting Antenna. *Pract. Vet. Surg*. 29, 437–444

Misek, J., Veternik, M., Tonhajzerova, I., Jakusova, V., Janousek, L and Jakus. J (2020). Radiofrequency electromagnetic field affects heart rate variability in rabbits. Physiological Research. 69(4): 633–643. . doi: 10.33549/physiolres.934425

Mollerlokken, O. J and Moen, B. E (2008). Is fertility reduced among men exposed to radiofrequency fields in the Norwegian Navy? *Bioelectromagnetics* 29:345–352.

Narayanan, S. N., Kumar, R. S., Potu, B. K., Nayak, S., Mailankot, M (2009) Spatial memory performance of Wistar rats exposure to mobile phone. *Clinics* (Sao Paulo), 64 (3): 231–234.

Nittby, H., Grafström, G., Tian, D. P., Malmgren, L., Brun, A., Persson, B. R. R., Salford, L. G and Eberhardt, J (2008). Radiofrequency and extremely low-frequency electromagnetic field effects on the blood-brain barrier *Electromagnetic Bio Med* (29): 219–232.

Notter, D. R; Lucas, J. R; McClangerty, F. S and Cpenhaver, J. S (1985). Breed group Differences in testicular growth patterns in spring- born lambs. *J. Anim. Sci*. 60: 622- 631.

Oksay, T., Naziroğlu, M., Doğan, S., Guzel, A., Gumral, N., and Koşar, P. A (2014). Protective effects of melatonin against oxidative injury in rat testis induced by wireless (2.45 GHz) devices. *Andrologia*, 46, 65–72.

Oyeyemi, M. O; Akusu, M. O and Ola-Davies, O. E (2001). Effects of successive ejaculation on the spermiogram of West African Dwarf Goats. *Israel Veterinary Medical Association* 56(4).

Ozguner, M., Koyu, A., Cesur, G., Ural, M., Ozguner, F., Gokcimen, A. and Delibas, N (2005). Biological and morphological effects on the reproductive organ of rats after exposure to electromagnetic field. *Saudi Medical Journal*, 26:(3): 405-410.

Pieri, C and Marcheselli, F (1994). Melatonin; A peroxyl radical scavenger more effective than Vitamin E. *Life Science.* 55(15) 271-276

Sepehrimanesh, M., Saeb, M., Nazifi, S., Kazemipour, N., Jelodar, G and Saeb, S (2014). Impact of 900 MHz electromagnetic field exposure on main male reproductive hormone levels: a *Rattus norvegicus* model. *International Journal of Biometeorology* 58:1657–1663

Sultama, I. K and Edey, T. N (1985). Reproductive development during winter and spring of merino ram lambs growth at three different rates. *Aust. J. Agric. Res*. 36: 461- 467.

Vishki, R., Majd, F. A., Nejadsat tari, T. and Arbabian, S (2012). Effects of electromagnetic field radiation on inducing physiological and biochemical changes in *Satureja bachtiarica* L. *Iranian Journal of Plant Physiology,* 2(4):509 - 516.

Wang, S. M., Wang, D. W and Peng, R. Y (2003). Effect of electromagnetic pulse irradiation on structure and function of Leydig cells in mice. pathologic levels of reactive oxygen species in neat semen of infertile men. Fertility and Sterility, 92(5), 1626–1631.

Webster, C. C and Wilson, P. N (1989). *Agriculture in the tropics* 4th Edition. Tropical Agriculture Series, Longman, Scientific and Technical, England.