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RESEARCH ARTICLE

Effects of Electromagnetic Waves of Mobile Phone Towers on Lipid profile, Liver functions and Blood Electrolytes of Human Beings

Wissam Sajid Hashim Al-Uboody*

*Department of Physiology and Medical Physics, College of Medicine, University of Al-Muthanna, Iraq

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***Corresponding Author**

Wissam Sajid Hashim Al-Uboody

Abstract

In present study, some biochemical parameters were accomplished to assess the effects of electromagnetic waves of cellular phone towers on human beings. Four Iraqi governorates were chosen to collect human blood samples, those are: Basra, Thiqar, Maisan and Najaf.

Total of four hundreds (400) blood samples were collected from volunteer men whose ages were ranging from 30 – 40 years old as 100 samples from each governorate. From each governorate; fifty samples were collected randomly from people who have dwelt at least for one year in houses very close to -not more 200 miters far- mobile phone towers and from different areas, and those people called as (Exposed). In addition, another fifty blood samples were collected randomly from people who dwelt in houses very far from the mobile phone towers to be as a control and they were called as (Not exposed). The biochemical results showed a significant increase in total serum cholesterol (TSCH), triglycerides (TGs), low density lipoprotein (LDL), very low density lipoprotein (VLDL), transaminases (AST , ALT), and blood calcium (Ca^{++}) of the exposed people in all of the four governorates with a significant increase in high density lipoprotein (HDL) of all governorates except that of Maisan governorate where it decreased but not significantly in the exposed group, while blood potassium (K^{+}) of the exposed people showed significant increase in Thiqar and Maisan governorates and not significant increase in Basra and Najaf governorates as compared to the parameters of non exposed people in all governorates at ($P \leq 0.05$).

INTRODUCTION

Cell phones have become indispensable devices in our daily life. These phones operate between 400 MHz and 2000 MHz frequency bands and emit radiofrequency electromagnetic waves (EMW) (Agarwal et al., 2008). The use of microwave (MW) radiation is fundamental not only in modern communications systems such as mobile telephones, but also in Nuclear Magnetic Resonance Diagnostic Imaging and Hyperthermia and Thermal Ablation Therapeutic techniques (Aweda et al., 2010). EMW produce thermal effects on biological systems at high power levels .The energy absorption at high power levels probably leads to nonspecific stimulation of hypothalamic-hypophysealadrenal axis with liberation of corticosterone that causes sequestration of cells, an effect induced by any known stressor. Some of the thermal effects reported include cataract formation, foetal abnormalities, decreased thyroid function (through hypothalamic hypophyseal- thyroid axis inhibition), suppression of behavioural responses, gonadal function and natural killer cell activity, increase in the number of complement receptor positive cells and increased phagocytic activity of peritoneal macrophages (Nageswari, 2003). EMW also effect different biochemical parameters such as total serum cholesterol (TSCH), LDL, HDL, VLDL, triglycerides, AST, and ALT (Yaghmaei et al., 2010), calcium level (Blackman, 1990) and potassium level (Đinđić et al., 2010).

Materials and Methods

Specimens' collection

Four Governorates were chosen to collect human blood samples from, those are: Basra, Thiqar, Maisan and Najaf.

Total of 400 blood samples were collected from the all four governorates. From each Governorate, 50 blood samples were collected randomly from volunteer men whose ages were ranging from 30 – 40 years old, they have dwelt at least for one year in houses very close to -not more 200 miters far- mobile phones towers and from different areas, and those people called as (Exposed). In addition, another 50 blood samples were collected from volunteer people who dwelt in houses very far from the mobile phones towers to be as a control and they were called (Not exposed).

Once blood samples were collected as 5 ml/ people by the use of disposable syringes, they were poured into glass test tubes free from anticoagulant to isolate blood serum to accomplish the necessary study parameters.

Study parameters

All study parameters were measured by the use of special kits and a UV spectrophotometer (APEL – PD 303 UV, Japan).

1. Total Serum Cholesterol, TCH (mg/dl)
Total serum cholesterol (TSCH) is enzymatically measured by using a chemical kit (SPINREACT/CHOD – POD, SPAIN) according to the method of (Naito and Kaplan, 1984; Young, 2001).

2. Low density lipoprotein, LDL (mg/dl)
Serum LDL was calculated by Friedewald formula: LDL-C = TC – HDL-C – TAG/5 (Friedewald et al., 1972).

3. High density lipoprotein, HDL (mg/dl))
Serum high density lipoprotein – cholesterol (HDL-C) is measured by using a chemical kit (HDL-CHOLESTEROL (PTA) / BIOLABO SA, FRANCE) according to the method of (Tietz, 1999).

4. Serum very low density lipoprotein-cholesterol, VLDL (mg/dl).
Serum very low density lipoprotein was calculated by dividing serum TAG by five based on method of (Friedewald et al., 1972).VLDL = TAG / 5VLDL (mg/dl).

5. Triglycerides (TGs)

Triglycerides (TGs) are enzymatically measured by using a chemical kit (TRIGLYCERIDES (GPO) / BIOLABO SA, FRANCE), depending upon the method of (Tietz, 1999; Fossati and Prencipe, 1982).

6. Blood Calcium level (mg/dl)
Blood Calcium level was estimated by the use of a special kit (Biomaghreb) according to method of (Stern and Lewis, 1957).

7. Blood Potassium level (mEq / l)
Blood Potassium level was estimated by the use of a special kit (CYPRESS DIAGNOSTICS) based on the method mentioned by (Tietz, 1999; Young, 2001).

8. Serum transaminases activity determination (Unit/ml)
ALT and AST enzymes were determined by the use of a special kit (BIOMERIEUX, LYON-FRANCE) according to method of (Reitman and Frankel, 1957).

9. Statistical analysis
One way Anova tests was used to find the least significant differences (LSD) among groups of all governorates by the use of SPSS version 21 program.

Results and Discussion

The results of the biochemical study showed that TSCH, TGs, LDL, VLDL, ALT, AST and Ca^{++} of the exposed groups in all chosen governorates had increased significantly and the HDL also increased significantly in all governorates except of Maisan where it decreased but not significantly at ($P \leq 0.05$) comparing with those of non-exposed groups. Blood K^+ of the exposed groups also increased significantly in Thiqar and Maisan beside a not significant increase in Basra and Najaf as it's clear from tables (1 and 2).

In children and adolescents, hyperlipidemia may generally be as a result of either obesity or effect of medications (McCrindle, 2000). Lipid abnormalities have been reported to be generally associated with vascular pathology (Weijenberg et al., 2009). LDL is the primary plasma lipid carrier with a single apolipoprotein molecule B-100 per particle. Apolipoprotein B-100 is a 500 kD peptide chain, one of the largest known monomeric proteins, highly insoluble in aqueous environment, which in contrary to other apolipoprotein is not substitutable by other lipoprotein particles. It is of hepatic origin, reaching the circulatory system via the very-low-density lipoproteins, which constitute LDL through the process of gradual intravascular remodelling. LDL constitutes highly atherogenic particles that, dominantly over other lipoproteins, favour cholesterol accumulation in foam cells produced by macrophages. The elevated status of LDL contributes to accelerated atherosclerosis, with demonstration of cardiovascular diseases within the first 2 decades of life for homozygotes (Al-Shaikh et al., 2002) and beginning in early to mid-adulthood for heterozygotes (Umans-Eckenhausen et al., 2001). MW exposures affect the peroxidation status in mammals and oxidation reactions may have been involved, leading to production of radicals, peroxides, superoxides etc. (Aweda et al., 2002). Reactive oxygen species (ROS) are very small molecules that include oxygen ions, free radicals and peroxides, both inorganic and organic that are highly reactive due to their unpaired valence electrons. Due to environmental stress resulting from MW, ionizing radiations and heat exposures, ROS levels can increase dramatically, and this may result in significant damage to cell structures. ROS can damage DNA, RNA and proteins which theoretically contributes to the physiology of aging, oxidations of poly-desaturated fatty acids in lipids, oxidation of amino acids in proteins and inactivate specific enzymes by oxidation of co-factors. While ROS are products of normal cellular functioning, excessive amounts can cause deleterious effects (Marian et al., 2007). Eventually, EMW interactions in biological tissues lead to production of ROS which cause oxidative reactions that eventually affect the status of the physiological parameters TCL, LDL, HDL, VLDL and TGR (Aweda et al., 2010).

As it is known, AST and ALT are synthesized by hepatocyte cells and they are sensitive and specific enzymes for liver disease (Senturk et al., 2004). Although these enzymes are expressed at a highest level in liver, they are also found in other tissues such as kidney, muscle and heart (Bellinger and Sloman, 1991; Minuk, 1998). In humans, AST and ALT levels rise during periods of chronic alcoholism, hepatocellular carcinoma and tissue injury (Garba and Gregory, 2005). Exposing to electromagnetic fields in humans or animals result in increasing glucorticoids (cortisol), stress oxidative compounds and produced hipoxy. This is an important reason for increasing of amount of trans-aminases in experimental groups. Hipoxy production could increase the AST and ALT value in serum, up to thousands of units in liter (Charles et al., 2003; Amara et al., 2006). Electromagnetic fields cause increase of transamination process. Production of stress oxidative compounds could be the reason of foregoing process which is in association with (Dicarlo et al., 2000; Parichehr et al., 2010).

The increase in blood calcium is well elicited by (Goldsworthy, 2006, 2007) who mentioned that most biological membranes are negatively charged, which makes them attract and adsorb positive ions. However, these ions are not stuck permanently to the membrane but are in dynamic equilibrium with the free ions in the environment. The relative amounts of each kind of ion attached at any one time depends mainly on its availability in the surroundings, the number of positive charges it carries and its chemical affinity for the membrane. Calcium normally predominates since it has a double positive charge that binds it firmly to the negative membrane. Potassium is also important since despite having only one charge, its sheer abundance ensures it a good representation (potassium is by far the most abundant positive ion in virtually all living cells and outnumbers calcium by about ten thousand to one in the cytosol). When an alternating electrical field from an eddy current hits a membrane, it will tug the bound positive ions away during the negative half-cycle and drive them back in the positive half-cycle. If the field is weak, strongly charged ions (such as calcium with its double charge) will be preferentially dislodged. Potassium (which has only one charge) will be less attracted by the field and mostly stay in position. Also, the less affected free potassium will tend to replace the lost calcium. In this way, weak fields increase the proportion of potassium ions bound to the membrane, and release the surplus calcium into the surroundings.

The significant increase in potassium of exposed groups could be an indicator of cellular membranes damage. Probably, this is the consequence of increased membrane permeability and potassium leaking, induced by oxidative damage or by impaired function of ions canals (Goldsworthy, 2007).

Table (1). Effect of (EMW) on lipids profile of humans in Some Iraqi governorates. The numbers represent the Mean ± Standard Deviation. The different letters refer to significant differences between groups.

Govern.	Groups / Parameters	TCH (mg/dl)	TGs (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	VLDL (mg/dl)
Najaf	**Not exposed**	148.5 ± 8.9 e	128.5 ± 8.9 d	98.5 ± 8.9 c	24.1 ± 1.8 c	25.7 ± 1.7 d
	Exposed	346.2 ± 22.7 b	226.2 ± 22.7 b	163.5 ± 19 b	137.5 ± 3.3 a	45.2 ± 4.5 b
Basrah	**Not exposed**	168.5 ± 17 e	139.7 ± 16.2 d	100.6 ± 7.8 c	39.7 ± 22.5	27.6 ± 3.4 d
	Exposed	385.6 ± 21.6 a	266.2 ± 55 a	179.7 ± 17.2 a	152.6 ± 29.2 a	53.2 ± 11 a
Thiqar	**Not exposed**	165.8 ± 11.9 e	143.8 ± 17.2 d	59.5 ± 11 d,e	77.3 ± 10.2 b	28.6 ± 3.3 d
	Exposed	297.1 ± 28.5 c	184.6 ± 6.9 c	99.7 ± 12.3 c	159.2 ± 39.6 a	35.5 ± 2.5 c
Maisan	**Not exposed**	141.5 ± 7.6 e	118.5 ± 7.6 d	78.5 ± 7.6 d	32.2 ± 6.8 c	23.6 ± 1.4 d
	Exposed	252.5 ± 29.1 d	182.5 ± 29.1 c	67.5 ± 23.9 d	148.5 ± 5.4 a	36.5 ± 5.8 c
LSD		**27.3**	**38.6**	**16.2**	**21.7**	**6.8**

Table (2). Effect of (EMW) on liver function enzymes and some blood electrolytes of humans in some Iraqi governorates. The numbers represent the Mean ± Standard Deviation. The different letters refer to significant differences between groups.

Govern.	Groups / Parameters	ALT (Unit/ml)	AST (Unit/ml)	Ca^{++} (mg/dl)	K (mEq / l)
Najaf	**Not exposed**	46.4 ± 10.8 b	39 ± 12.8 b	9.5 ± 2.8 b	4.7 ± 2 b
	Exposed	63.6 ± 15.1 a	75.1 ± 10.7 a	109.4 ± 20.8 a	5.8 ± 3.2 a,b
Basrah	**Not exposed**	41.1 ± 2.4 b	32.5 ± 4.5 b	10.8 ± 2 b	3.3 ± 1.5 b,a
	Exposed	57.3 ± 6.2 a	75.5 ± 4.8 a	117.1 ± 13.3 a	4.8 ± 2 b

Thiqar	Not exposed	44.5 ± 5.4 b	31.1 ± 6.4 b	10.7 ± 3 b	4.7 ± 2.1 b
	Exposed	63.8 ± 8.5 a	78.5 ± 8.6 a	107.3 ± 20.4 a	7.2 ± 3.6 a
Maisan	Not exposed	44.5 ± 5.4 b	32.1 ± 7.4 b	11 ± 2.7 b	4.5 ± 3 b,a
	Exposed	69.5 ± 12.4 a	80.7 ± 12.5 a	109.5 ± 22.7 a	8 ± 3.9 a
LSD		**10.8**	**36.1**	**96.3**	**3.17**

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