

## Calculation of Heart Rate Variation Owing to the Effect of Electromagnetic Fields Waves (EMF)

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### KEYWORDS :

- Information technology
- Radio waves
- Magnetic field
- SAR
- Heart rate variation
- ECG

### ABSTRACT

The chemical reactions that Occur as part of the normal body functions, generated tiny electrical current in the human body. Even in the absence of external electric fields so that exposure to external radiation causes high impact on the nerves signals by transmitting electric impulses. The heart is electrically active and its act

ons can be measured using an electrocardiogram. Noted slight variation in heart rate may cause serious effects on the human body. The field of electromagnetic emitted from advanced phones has been effect on work of the human heart. In this research taken samples were subjected to examination with presence of phone devices in normal mode and case of vibration when ringing. The study was carried out by taking electrocardiogram (ECG) for group of samples (students) to study the EMF effect of modern phones. After viewing ECG results this area of radiation is shown to cause a negative long-term effect. This effect will be obvious to the human heart and to other parts of its body.

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### حساب معدل اختلاف ضربات القلب بسبب تأثير مجالات الكهرومغناطيسية

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### الكلمات المفتاحية:

- تكنولوجيا المعلومات
- موجات الراديو
- المجال المغناطيسي
- اختلاف معدل ضربات القلب
- جهاز تخطيط القلب

### الخلاصة

التفاعلات الكيميائية التي تحدث كجزء من وظائف الجسم الطبيعية ، تولد تيار كهربائي صغيرة جدا في جسم الإنسان، حتى في غياب الحقول الكهربائية الخارجية . التعرض للإشعاع الخارجي بسبب تأثير كبير على النبضات الكهربائية الناقلة للإشارات العصبية. القلب نشط كهربائيا ويمكن قياس أفعاله باستخدام جهاز تخطيط القلب (electrocardiogram). التغيير الطفيف الملحوظ في معدل ضربات القلب قد يسبب تأثيرات خطيرة على جسم الإنسان. المجال الكهرومغناطيسي المنبعث من الهواتف المتطورة تؤثر على عمل قلب الانسان. في هذا البحث اخضعت العينات للفحص مع وجود أجهزة الهاتف في الوضع العادي وحالة الاهتزاز عند الرنين. أجريت الدراسة عن طريق أخذ تخطيط القلب (ECG) لمجموعة من العينات (طلبة) لدراسة تأثير المجالات الكهرومغناطيسية (EMF) للهواتف النقالة الحديثة. بعد عرض نتائج جهاز تخطيط القلب ظهر أن هذه المنطقة من الإشعاع (الموجات الصادرة من الأجهزة الناقلة) تسبب تأثير سلبي على المدى الطويل. سيكون التأثير واضحاً على قلب الإنسان و على أجزاء أخرى من جسمه.

## 1. Introduction

There are fields generated besides natural sources of electromagnetic spectrum, these generated by human-made sources [1].

The electricity that comes out of every power plug has low frequency electro-magnetic fields. Higher frequency radio waves are used to transmit information via TV antennas, radio stations or mobile phone base stations. Smartphones emit electro-magnetic fields ranging change from 900 to 2000 MHz which are supposed to have an influence on well-being, attention and neurological parameters in Smart-phones users [2]. Electromagnetic fields (EMF) of different frequencies interact with the body in different ways. Radio frequencies are the natural consequence of electronic devices and wireless which are associated with broadcasting media, such as television and radio sending. Anything that has an antenna emits radio waves and this includes wireless handsets. The lengthy use of such cellular devices affects the overall health of the human body because of the high dose radiation evolving from such electronic devices stress to the cardiac system. This stress affecting heart may damage the heart muscles leading to cardiac arrest [3]. Based on investigations, it is stated that the one who use mobile phones frequently gets tiredness, depression, fatigue and headache often than the one who use them rarely. Hence it is recommended to limit the frequent use of handsets. Systematic lab-oratory studies reveal that exposure to electromagnetic radiation affects the internal organs like heart and brain cells directly or indirectly. Such effects may not be noticed in a short interval of time. It may even cause side effects in most cases [4].

Environmental exposure to human-made electromagnetic fields has been steadily increasing because of high electricity demand, technological growth and changes in social behavior have created more artificial sources.

Almost all human beings are exposed to a complex mix of weak electric and magnetic fields, both at home and at work. Studies are performed on the amount of radiation absorbed by the body and the corresponding analyses are made. Low-level electromagnetic waves produce a biological effect that is not harmful. But in case of high-intensity waves, these effects may be harmful as it produces burns, cataracts, chemical changes, headache and cardiac problems. Exposure to certain radio frequency waves is useful in the medical field as it acts as a remedy for some types of illness[5]. One of the most reliable effects observed in these studies is the increase of EEG power during sleep due to the exposure of pulse-modulated Radio Frequency Electromagnetic Fields (RF-EMF) which alters brain activity in the sleep spindle frequency range. Experimental research is conducted among volunteers with mobile phone and sham exposure in which cardiac regulatory mechanism in different Autonomic Nervous Systems (ANS) are assessed. The analysis of the data shows that there was no statistically significant effect due to EMF exposure in case of shorter duration [6]. The main observed health adverse effects have been related either to the induction of electric currents in the body which induce nerve stimulation or to the temperature increase leading to heat stress. Metallic devices are well known to strongly interact with EMF by diffraction leading to a significant local enhancement of field intensity [7].

## 2. Theory of Electrocardiography

QRS wave (figure 1) is straight in a main when the axis is aligned with its main vector. The overall direction of depolarization and repolarization produces a vector that produces positive or negative deflection in the ECG [8]. Normal rhythm produces four entities namely P wave, QRS complex, T wave and (U) wave where, (P) wave represents atrial depolarization, QRS com-

plex represents ventricular depolarization, (T) wave represents ventricular repolarization and U wave represents papillary muscle repolarization [9]

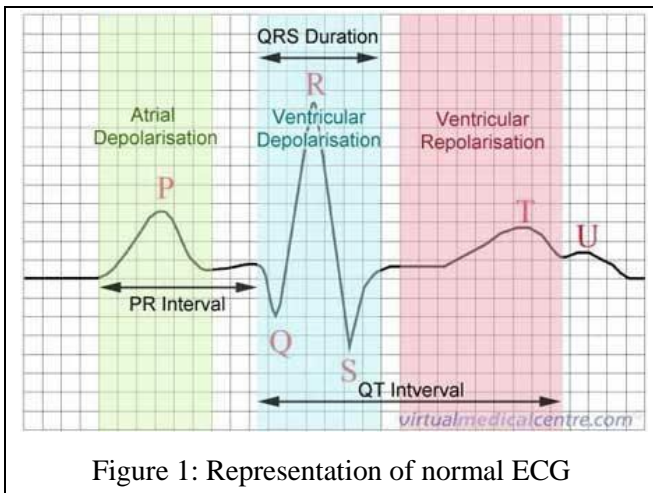


Figure 1: Representation of normal ECG

Electrocardiography (ECG) is a widely used for recording electrical changes in the heart, which is called electrocardiogram. (ECG or EKG), shows the series of waves that linked to the beats of electrical which occur through each beat of the heart. Results printed on paper or show on a monitor [10]. The waves in a normal record named as P, Q, R, S, and T and follow in alphabetical order. The number of waves may differ, and other waves may be extant.

ECG is represent starting point for discovering the many problems of heart. It is used routinely in monitoring the patient's condition during and after surgery, as well as during intensive care. It is the basic measurement used for tests such as basic things. It is used to evaluate causes of symptoms such as chest pain, shortness of breath, and palpitations [11].

### 3. Methodologies

Cardiart ECG machine 108T Digi and silver chloride electrodes were used to conduct the experiments on different phone modes. Some students were subjected to the experiment and their ECG under normal and vibration + ring modes were recorded for further analysis. Four-limb electrodes on both hands and legs

and one suction cup electrode on the chest were used to perform this demonstration.

The ECGs of samples, aged between 20 and 30 are recorded by using 3 lead ECG as shown in (figure 2).

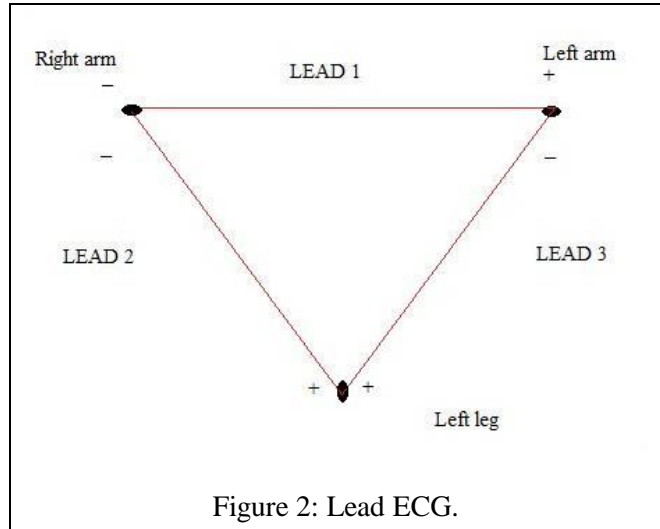


Figure 2: Lead ECG.

Subject's blood pressure is checked "by specialization in heart" to ensure whether the subject is in normal condition. As per the criteria, subject is chosen and the required pulses are recorded over both hands and legs. Then, ECG jelly is applied while placing the limb electrodes on the hands and legs. One suction cup electrode is placed on the chest near the SA node of the heart. Finally, ECG of the object under normal condition is taken and thereby the waveforms are analyzed.

### 4. Result Analysis

The normal ECG of a sample student is given in (figure 3)

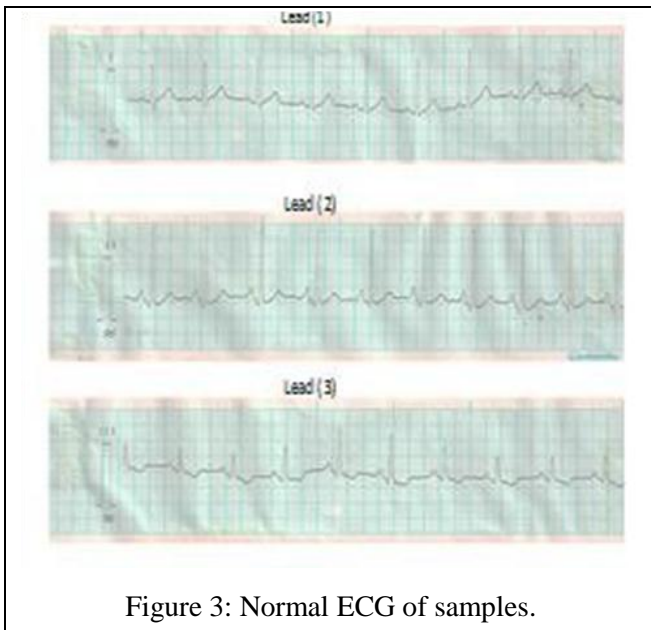


Figure 3: Normal ECG of samples.

The 3 lead ECG is the most commonly used ECG in continuous monitoring of the person with any cardiac problem. It is simple to use and capable of picking up the specific electrical rhythm of the heart without interference.

Table: 1 shows the ECG value of samples. The average of heart rate (bpm) of sample1, sample2, sample3, sample4 and sample5 under normal condition of phone was 64.76.

In vibration + ring condition, the average (bpm) for the five samples was results 67.34.

The variation in bpm average is found out. Heart rate reading in normal and vibration +

ring condition is tabulated in table 2. Heart rate changes considerably in the normal mode due to the maximum utilization of EMF radiation which are very harmful to the heart whereas a part of the signal is utilized for vibration and ringtone in vibration + ring condition.

### 5. Conclusions

One way to manage stress is to avoid frequent use of cellular phones and thereby reduce the exposure of electromagnetic waves. It is encouraged to switch off these devices emitting electromagnetic waves when not in use. By doing so, EMF radiation exposure to the body is prevented to a certain time limit. cellular phones with low specific absorption rate are considered for better use. Text messages to voice calls are preferred in which the exposure of EMF waves to brain cells are reduced. In future, techniques may emerge so as to reduce the emission of EMF waves from mobile phones or to introduce any filtering methods to limit such waves.

After viewing ECG results this area of radiation is shown to cause a negative long-term effect. This effect will be obvious to the human heart and to other parts of its body.

**Table 1: ECG readings in both normal and vibration phone modes.**

Samples		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Normal mode	P	0.062	0.08	0.08	0.10	0.06
	PR	0.18	0.16	0.16	0.12	0.18
	QT	0.29	0.29	0.34	0.36	0.28
	ST	0.32	0.226	0.27	0.34	0.32
	QRS	0.076	0.12	0.08	0.08	0.08
	RR	25.92	25.06	25	17.73	26.1
	bpm	60	59.8	60	84	60
Vibration mode	P	0.062	0.10	0.08	0.75	0.06
	PR	0.16	0.16	0.16	0.12	0.16
	QT	0.35	0.38	0.36	0.36	0.32
	ST	0.32	0.32	0.32	0.28	0.2
	QRS	0.08	0.086	0.08	0.08	0.07
	RR	22.66	22.50	25.8	17.4	25
	bpm	66	66.6	58.13	86	60

**Table 2: Heart rate readings in normal and vibration mode.**

Factor	Sample 1		Sample 2		Sample 3		Sample 4		Sample 5	
	NM	VM	NM	VM	NM	VM	NM	VM	NM	VM
HR	60	66	59.8	66.6	60	58.13	84	86	60	60
AvgHR	64.76	67.34	64.76	67.34	64.76	67.34	64.76	67.34	64.76	67.34
HR-Avg HR (x)	-4.76	-1.34	-4.96	-0.74	-4.76	9.21	19.24	18.66	-4.76	-7.34
$x^2$	22.65	1.79	24.6	0.54	22.65	84.82	370	348	22.65	53.87
Delta	2.37	0.66	2.47	0.36	2.37	4.60	9.61	9.32	2.37	3.66

NM= Normal Mode, VM= Vibration Mode, HR= Heart Rate, Avg = Average

## References

- [1] James c. Lin, Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300GHz, IEEE Std 95.1-2005 (Revision of IEEE Std c95.1-1991), 2006, pp.1-238,
- [2] J. c. Lin, Safety Standards for Human Exposure to Radio Frequency Radiation and their Biological Rationale, IEEE Microwave Magazine, Vol.4, No.4, 2003, pp.22-26.
- [3] c. c. Johnson and A. W. Guy, Nonionizing Electromagnetic Wave Effects in Biological Materials and Systems, Proceeding of the IEEE, Vol.60, No.6, 2005, pp. 692-718.
- [4] Reto Huber, Jurgen Schuderer, Thomas Graf, Kathrin Jutz, Alexander A. Borbely, Niels Kuster and Peter Achermann, Radio Frequency Electromagnetic Field Exposure In Humans: Estimation of SAR Distribution in the Brain, Effects on Sleep and Heart Rate, Bioelectro-magnetics, Vol. 24, No. 4, 2003, pp. 262-276.
- [5] Kleinlogel, T. Dierks, T. Koenig, H. Lehmann, A. Minder and Berz, Effects of Weak Mobile Phone –Electromagnetic Fields (GSM,UMTS) on Well-Being and Resting EEG, Bioelectromagnetics, Vol. 29, No.6, 2008, pp. 479-487.
- [6] R. Huber, V. Treyer, A. A. Borbely, J. Schuderer, J. M. Gottselig, H. P. Landolt, E. Werth, T. Berthold, N. Kuster, A. Buck and P. Achermann, Electromagnetic Fields, such as those from Mobile Phones, Alter Regional cerebral Blood Flow and Sleep and Waking EEG, Journal of Sleep Research, Vol.11, No.4, 2002, pp.289-295.
- [7] V. Joshi Rajendra and H. D. Khanna, Effect of Electromagnetic Fields Emitted by cellular Phone Base Station on Human Health, Indian Journal of Applied Basic Medical Sciences, Vol.17a, No.24, 2015, pp.20-27.
- [8] Caroline Lustenberger, Manuel Murbach, Laura Tüshaus, Flavia Wehrle, Niels Kuster, Peter Achermann and R.Huber, Inter- Individual and Intra-Individual Variation of the Effects of Pulsed RF EMF



- Exposure on the Human Sleep EEG, Bioelectromagnetics, Vol. 36, No. 3, 2015, pp. 169–177.
- [9] Marta Parazzini, Paolo Ravazzani, Gabriella Tognola, Gyorgy Thuroczy, Ferenc B. Molnar, Alessio Sacchetti, Gianluca Ardesi and Luca Tommaso Mainardi, Electromagnetic Fields Produced by GSM cellular Phones and Heart Rate Variability, Vol.28, No.2, 2007, pp. 122–129.
- [10] D. Crouziera, L. Selekb, Martz, V. Dabouisa, R. Arnauda and J. Debouzya, Risk Assessment of Electromagnetic Fields Exposure With Metallic Orthopaedic Implants: A cadaveric Study, Orthopaedics & Traumatology: Surgery & Research, Vol. 98, No.1, 2012, pp.90–96,
- [11] C. D. Angelo, E. Costantina, M. A. Kamal and M. Reale, Experimental Model for ELF-EMF Exposure: concern for Human Health, Saudi Journal of Biological Sciences, Vol. 22, No.1, 2015, pp. 75–84.