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Effect of the Electromagnetic Field Radiation of Cell Phones on the Level of Blood Glucose in Rats

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Abstract

The widespread use of the mobile phone is accompanied by public debate about the possible harmful effects on human health. So far, no research has been published to establish any link between the fastest growing innovation of cell phones and the amount of fasting blood glucose. Our goal is to determine the effect of electromagnetic field radiation generated by cell phones on fasting blood glucose levels in Wistar albino rats. The 40 male albino rats (Wistar line) were divided into 5 equal groups. Group A was control, while group B received cell phone radiation for less than 15 minutes per day, group C - 15-30 min / day, group D - 31-45 min / day, and group E - 46-60 min / day for 3 months. Fasting blood glucose was determined by spectrometric method and insulin in blood serum by immuno-enzymatic analysis (ELISA). Wistar line albino rats, exposed to cell phone radiation for more than 15 minutes per day for 3 months, had fasting blood glucose levels ($p < 0.015$) and serum insulin levels ($p < 0.01$) higher than those in control groups. Insulin resistance was significantly increased ($p < 0.003$) in the affected groups at 15-30 and 46-60 min/day compared to the control rats. These studies have found an association between prolonged exposure to cell phones and increased blood glucose and serum insulin levels in Wistar line rats.

Keywords: cell phone radiation; blood glucose levels; insulin resistance.

1. Introduction

Cell phone use has grown significantly over the last decade, and high-tech mobile applications have become an integral part of personal activities and social life.

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Recently, they are even used in telemedicine interventions. Cell phones are changing and evolving at a very fast pace, and the number of cell phone users in the world has exceeded 4.8 billion, which means that every second person on our planet uses a cell phone [1, 5]

A cell/mobile phone is a low power radio device that transmits and receives radio frequency radiation of 900-2000 MHz. It is mainly worn in the front or side pockets of clothing or fastened to the belt, while during use it is held directly to the skull. Despite all the benefits that the cell phone has brought to the world community, cell phone users often report feeling burning or tingling around the ear. The rise in temperature may be due to exposure to radio frequency (RS) when using a mobile phone. Cell phone users also often complain of headaches, sleep disturbances, tension, fatigue, dizziness, impaired vision and hearing [4, 6, 9]. Cell phones have also been reported to adversely affect the central nervous system, cardiovascular and hematopoietic systems, as well as the seminal glad and the placenta functions. It has also been suggested that it has a carcinogenic effect and is characterized by potential effects on cellular DNA [10, 11, 13]. Electromagnetic waves generated by cell phones can cause both thermal and non-thermal effects. Despite the large number of studies published over the decades, it is still unclear whether cell phone use can cause serious problems such as cell phone-induced hyperglycemia. It is well known that eventually stable hyperglycemia eventually leads to diabetes mellitus [14].

Diabetes, which poses a global health problem with its devastating human, social and economic impact, could reach epidemic proportions by 2030. Currently, approximately 250 million people worldwide have diabetes, and it is estimated that by 2025 this number will increase to 380 million. Moreover, about 2 million people a year and two people per minute die from complications caused by diabetes. It seems appropriate to consider the fact that the use of mobile phones has increased over the last decade and, similarly, the prevalence of diabetes has increased quite dramatically. To date, no studies have been published proving any link between the fastest growing innovations in the world, i.e., the cell/mobile phone, and the rapidly developing hyperglycemia / diabetes mellitus [1].

Thus, the aim of this study was to investigate the effect of electromagnetic field radiation generated by cell phones on changes in fasting blood glucose levels in Wistar line albino rats.

2. Materials and methods

Animal model: 40 male rats of the same genetic line, 2 months old, weighing 150–160 g, were selected for the experiment. The animals were housed (8 animals in each cage), fed with a standard grain food (Gold Mohar) and provided with unlimited water supply. The rats were kept at a strictly protected temperature of 22–24 ° C and had a 12–12 h light and dark cycle (light from 6:00 am to 6:00 pm). The Animal Ethics Council approved the animal experimental protocol and the experiment was conducted in accordance with the proposed guidelines.

All animals were divided into five groups. Group A was the control group, while the other four groups (B, C, D and E) were exposed to microwave radiation generated by the mobile phone, group B: <15 min, group C: 15-30 min, group D: 31-45 min and Group E: 46-60 min daily within 12 hours for 3 months. Mobile phones of the

same brand and model were used in this experiment. The GSM (Global System for Mobile Communications) calls from one mobile phone to another, and it automatically rings once every 10 minutes. Once we made sure that the cell phone was in reply mode (answer mode), the cell phone was placed directly on the cage in its center to ensure evenly distributed electromagnetic radiation throughout the animal body. The animals were very close to the cell phone. The electromagnetic field emitted by the mobile phones was about 1800 MHz.

Fasting blood glucose and insulin analysis

blood samples were taken from the tail vein, blood samples were coagulated at room temperature and then centrifuged at 3000 rpm for 10 minutes; the separated serum was stored at -70° C before analysis. Blood glucose was determined spectrophotometrically [2], and serum insulin was determined by immune-enzymatic assay (ELISA) set 96.

Homeostasis Model Evaluation (HMS)

to determine insulin resistance and pancreatic β-cell function, the Homeostasis Model (HMS) provides valid and reliable information to determine fasting blood glucose levels and serum insulin. This is the simplest and most popular model for determining β-cell function based on basal measurements of insulin and glucose. Comparison of fasting glucose values with model predictions allows quantitative assessment of insulin resistance and deficient β-cell function with hyperglycemia [3].

Statistical analysis

the data were uploaded into the computer applying SPSS version 13.0. A nonparametric Kruskal-Wallis statistical test was used to determine the values between the groups and a nonparametric Mann-Whitney test was used to compare the results between the control animals and the rats that were exposed to radiation emitted by mobile phones at different periods of time. The data were expressed as median ± mid-quarter range as well as mean ± standard deviation (SD). P-value < 0.05.

3. Results

Table 1 shows fasting glucose and serum insulin levels in Wistar line white rats that received cellular radiation <15, 15-30, 31-45, 46-60 min / day for 3 months compared with controls (Figs. 1 and 2). Fasting blood glucose significantly increased in animals exposed to irradiation at 15-30 min / day ($p < 0.01$) and 46–60 min / day ($p < 0.03$) compared to the control group. However, no significant difference in glucose was observed between the group that received cell phone irradiation for less than 15 min.

Fasting serum insulin levels showed a significant increase in animals after exposure to cell phone radiation at 31-45 min per day ($p < 0.01$) and 45-60 min per day ($p < 0.03$) compared to the control group. Nevertheless, no significant difference in serum insulin was observed in animals exposed to cell phone radiation for less than 15 min per day and 15-30 min/day for three months [3, 8].

Table 1: Comparison of the effect of the duration of exposure to electromagnetic field radiation generated by mobile phones on fasting blood glucose levels in Wistar line white rats mmol/L.

Parameter	Group A (n =8) Control	Group B (n =8) <15 ֆთ	Group C (n =8) 15-30ֆ	Group D (n =8) 31-45ֆთ	Group E (n =8) 46-60ֆ
Glucose quantity in blood M±SD	3.62±0.79	3.07±1.18	5.17±1.41	5.63±2.57	5.98±3.93

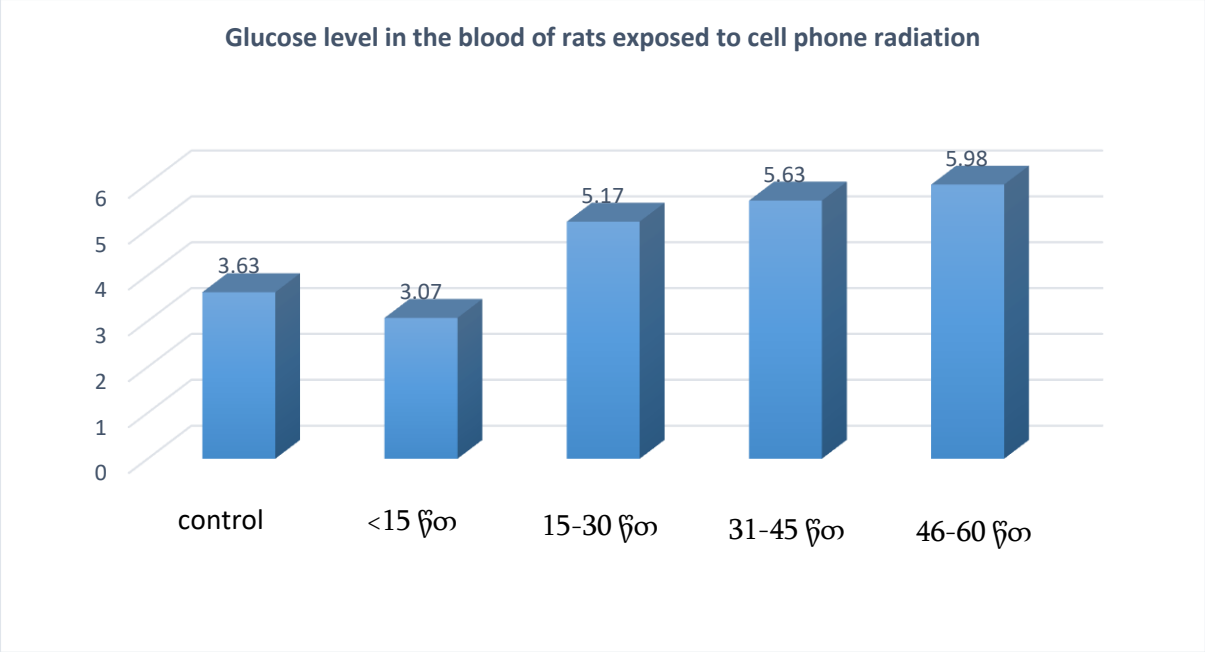

Figure 1: Cell phone radiation at different points in time and changes in blood glucose levels

Table 2: Comparison of the effect of duration of exposure to electromagnetic field radiation generated by mobile phones on fasting blood serum insulin ng/L.

Parameter	Group A (n=8) control	Group B (n=8) <15 ֆთ	Group C (n=8) 15-30 ֆთ	Group D (n=8) 31-45 ֆთ	Group E (n=8) 46 –60 ֆთ
M±SD	0.0396±0.0016	0.0398±0.0016	0.0416±0.003	0.0458±0.005	0.0426±0.002

Table 2 shows a comparison of β-cell function and serum insulin resistance between control animals and those exposed to cell phone radiation <15, 15-30, 31-45 and 46. -60 min/day for 3 months. No significant difference in β-cell function was found between control rats and rats exposed to cell phone radiation for less than 15 min during the day, but significant differences were observed in the other groups. Insulin resistance was significantly higher among rats exposed to cell phone radiation for 15–30 and 31–45 min / day for 3 months, but no significant differences in insulin resistance were observed for the groups exposed to cell phone radiation <15 min and 46-60 minutes per day.

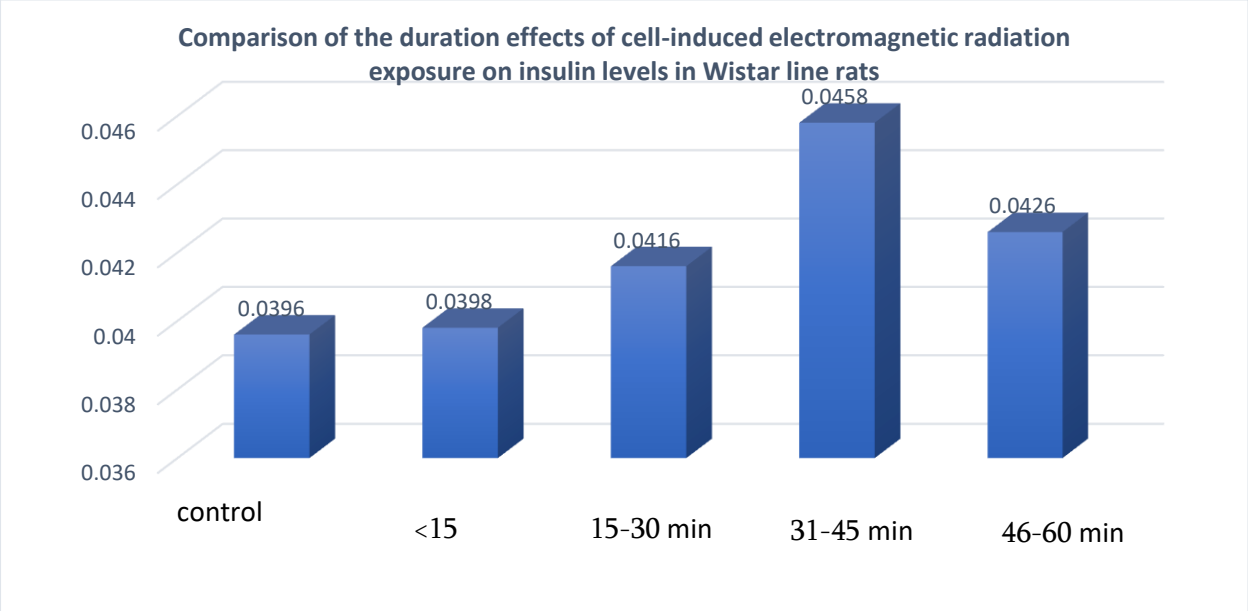

Figure 2: Comparison of the effect of duration of exposure to electromagnetic field radiation generated by mobile phones on serum insulin in Wistar line white rats.

4. Discussion

Physiological functions are mainly based on electrical phenomena to ensure that the body maintains sufficient strength to perform normal physiological functions. The potential biological impact of low-energy radiation emitted by mobile phones and the potential for health impacts remain controversial. Despite years of research, there is still debate as to whether such radiation can have any physiologically relevant effects. Most studies focus on headaches, sleep disorders, or allergy-like symptoms and cancer research. In addition, studies have also shown that cell phone radiation has a wide range of harmful effects on the brain, heart, male reproductive system, eyes and causes oxidative damage, but so far, no one has done so. No health study has been conducted to study a problem such as hyperglycemia caused by cell phone radiation.

This is the first study in the literature to show a significant increase in fasting serum glucose levels in Wistar line white rats exposed to cell phone radiation for 15-30 and 46-60 min / day for three months [7,8]. In addition, fasting serum insulin levels were found to increase significantly with exposure to cell phones at 31-45 and 46-60 min / day, respectively. It was also shown that HOMA-IR significantly increased in the groups exposed to 15-30 and 46-60 min/day.

The findings of the present study support the notion that exposure to cell phones at different times causes hyperglycemia with an immediate/significant increase in serum insulin levels [12,15]. It is logical that hyperglycemia causes insulin secretion. Finally, compensatory increases in insulin levels help control hyperglycemia [8,16].

In the study, we found that the Wistar line white rats, exposed to cell phones for 15 minutes, did not change their blood glucose and serum insulin. This shows the usual connection between them, i.e. when blood glucose was low, insulin level was also low. However, when the duration of exposure to cell phone radiation was increased (15-30, 31-45, and 45-60 min/day for 3 months), blood glucose increased because of compensatory increase in insulin levels to control hyperglycemia [14,17]. Persistent hyperglycemia causes early and severe dysfunction of β-cells, while excess glucose causes loss of β-cells through apoptosis. Cell phone radiation can alter genetic regulation and exacerbate oxidative stress. Oxidative stress can directly contribute to the development of diabetes by reducing insulin sensitivity and destroying pancreatic β-cells. It is well known that sooner or later the development of hyperglycemia eventually leads to the development of diabetes. Based on the results of our study and mobile phone radiation, it is important to find out if hyperglycemia is really related to β-cell dysfunction or insulin resistance. Diabetes mellitus is a metabolic disease characterized by hyperglycemia, a decrease in insulin secretion, in fact, reduced insulin secretion and its action often coexist with each other, and this pathology becomes the main cause of elevated blood glucose levels. In our study, hyperglycemia was most likely associated with increased insulin secretion. It is clear that hyperglycemia did not develop due to decreased insulin secretion. Given the association between hyperglycemia and increased insulin secretion, we used a homeostasis model assessment (HOMA) based on fasting glucose and insulin concentrations in fasting blood plasma levels. This model is widely used to quantify insulin resistance and β-cell function.

We found that HOMA-IR increased significantly and the increase in HOMA-IR reflects insulin resistance.

5. Conclusion

The results of our study showed an association between an increase in fasting blood glucose and serum insulin in rats under prolonged exposure to a cell phone. We cannot deny the benefits of the services provided by the mobile phone industry, but we also firmly believe that health is more important and cannot be compromised.

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