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A meta-analysis of in vitro exposures to weak radiofrequency radiation exposure from mobile phones (1990–2015)

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ABSTRACT

To function, mobile phone systems require transmitters that emit and receive radiofrequency signals over an extended geographical area exposing humans in all stages of development ranging from in-utero, early childhood, adolescents and adults. This study evaluates the question of the impact of radiofrequency radiation on living organisms in vitro studies. In this study, we abstract data from 300 peer-reviewed scientific publications (1990–2015) describing 1127 experimental observations in cell-based in vitro models. Our first analysis of these data found that out of 746 human cell experiments, 45.3% indicated cell changes, whereas 54.7% indicated no changes ($p = 0.001$). Realizing that there are profound distinctions between cell types in terms of age, rate of proliferation and apoptosis, and other characteristics and that RF signals can be characterized in terms of polarity, information content, frequency, Specific Absorption Rate (SAR) and power, we further refined our analysis to determine if there were some distinct properties of negative and positive findings associated with these specific characteristics. We further analyzed the data taking into account the cumulative effect (SAR × exposure time) to acquire the cumulative energy absorption of experiments due to radiofrequency exposure, which we believe, has not been fully considered previously. When the frequency of signals, length and type of exposure, and maturity, rate of growth (doubling time), apoptosis and other properties of individual cell types are considered, our results identify a number of potential non-thermal effects of radiofrequency fields that are restricted to a subset of specific faster-growing less differentiated cell types such as human spermatozoa (based on 19 reported experiments, p-value = 0.002) and human epithelial cells (based on 89 reported experiments, p-value < 0.0001). In contrast, for mature, differentiated adult cells of Glia ($p = 0.001$) and Glioblastoma ($p < 0.0001$) and adult human blood lymphocytes ($p < 0.0001$) there are no statistically significant differences for these more slowly reproducing cell lines. Thus, we show that RF induces significant changes in human cells (45.3%), and in faster-growing rat/mouse cell dataset (47.3%). In parallel with this finding, further analysis of faster-growing cells from other species (chicken, rabbit, pig, frog, snail) indicates that most undergo significant changes (74.4%) when exposed to RF. This study confirms observations from the REFLEX project, Belyaev and others that cellular response varies with signal properties. We concur that differentiation of cell type thus constitutes a critical piece of information and should be useful as a reference for many researchers planning additional studies. Sponsorship bias is also a factor that we did not take into account in this analysis.

1. Introduction

On May 31, 2011, the World Health Organization (WHO), International Agency for Research on Cancer (IARC) classified radiofrequency electromagnetic fields (RF-EMF) from mobile phones as a "Possible Human Carcinogen" (Group 2 B) (WHO and World Health Organisation, 2011) based on in vitro, in vivo and epidemiological studies; the Interphone Study (INTERPHONE Study, 2010) (some evidence to suggest increased risk of glioma in heavy adult users > 1640 h) and the Hardell et al. (2006) the study indicates increased risk of malignant brain tumors for users of cellular and cordless phones. The results from these studies have not been without controversy. Others (Swerdlow et al., 2011) suggests that there is no increase in risk, with several reviewing groups advising that mobile phone use is safe for adults as well as children (SCENIHR (SCENIHR, 2015), ICNIRP (International Commission on Non-Ionizing Radiation Protection (ICNIRP), 1998)). Furthermore, there are reports (International Commission on Non-Ionizing Radiation Protection (ICNIRP), 1998) that

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