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COMPARISON OF THE SENSITIVITY OF CANCER AND NORMAL HUMAN CELLS TO CHANGES IN BACKGROUND MAGNETIC FIELD

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INTRODUCTION & AIM

Geomagnetic conditions in modern urban environments are substantially altered and cannot be considered natural for humans. This is particularly relevant to **magnetic fields (MFs)** with intensities of up to 1 mT, which are classified as **weak magnetic fields (WMFs)**. Previous studies have demonstrated that WMFs can affect various biological processes; however, this intensity range remains insufficiently explored, and the available data are contradictory. In addition, little attention has been paid to the combined effects of magnetic fields and other stress factors.

The aim of this study was to investigate the effects of WMFs of different intensities on the growth of normal and cancerous human cells, both as an independent factor and in combination with serum deprivation.

METHOD

Figure 1. Three-axis Helmholtz coil system with a plate holder in the center, placed inside a BINDER C150 CO_2 incubator.

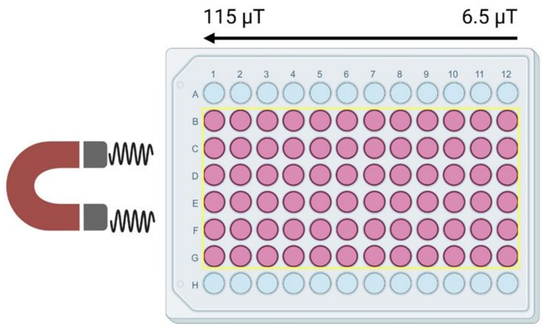


Figure 2. Experimental scheme showing a weak magnetic field gradient across the culture plate. Working wells containing cell cultures are highlighted in yellow. The MF intensity gradually increased from 6.5 µT to 115 µT across the plate.

Cell cultures

- immortalized human embryonic kidney cells **HEK-293T**;
- cervical adenocarcinoma cells **HeLa**;
- epidermoid carcinoma cells **A-431.**

Cells were seeded in 96-well plates and placed in the magnetic setup for 72 h. **Cell viability** was assessed using **the MTT assay**.

To assess **the effect of stress** conditions on cellular sensitivity to MF exposure, **the FBS concentration was reduced** from 10% to 3% for HEK-293T cells, while FBS was **completely removed** for HeLa and A-431 cells.

RESULTS

Cell Growth in a Uniform Magnetic Field

Cell growth in 96-well plates may vary depending on well position. To rule out this positional effect, cultures were first incubated inside the magnetic setup under a uniform magnetic field of 48 ± 3 µT, which lies within the geomagnetic range. No statistically significant differences in cell growth were detected across plate columns.

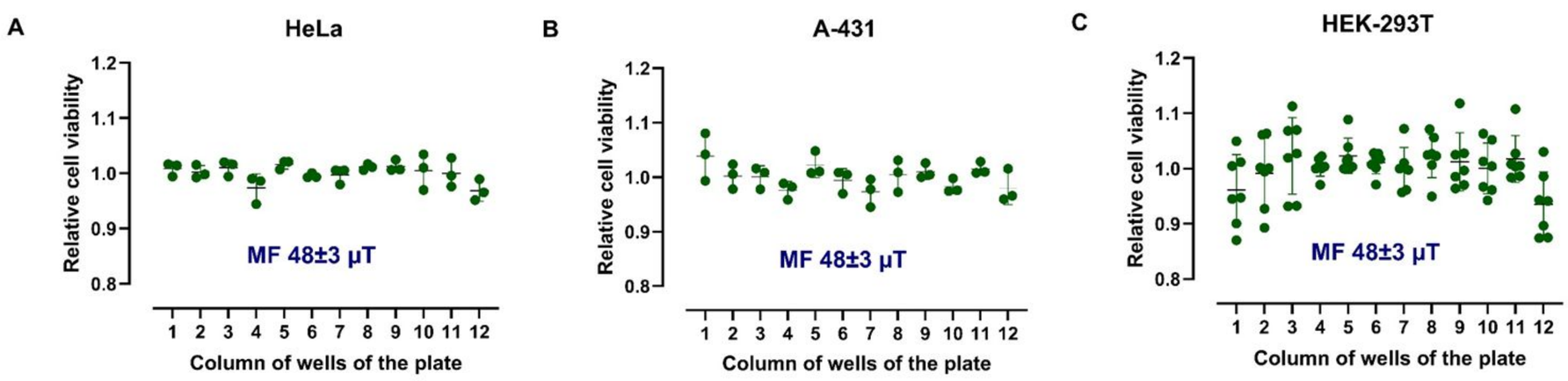
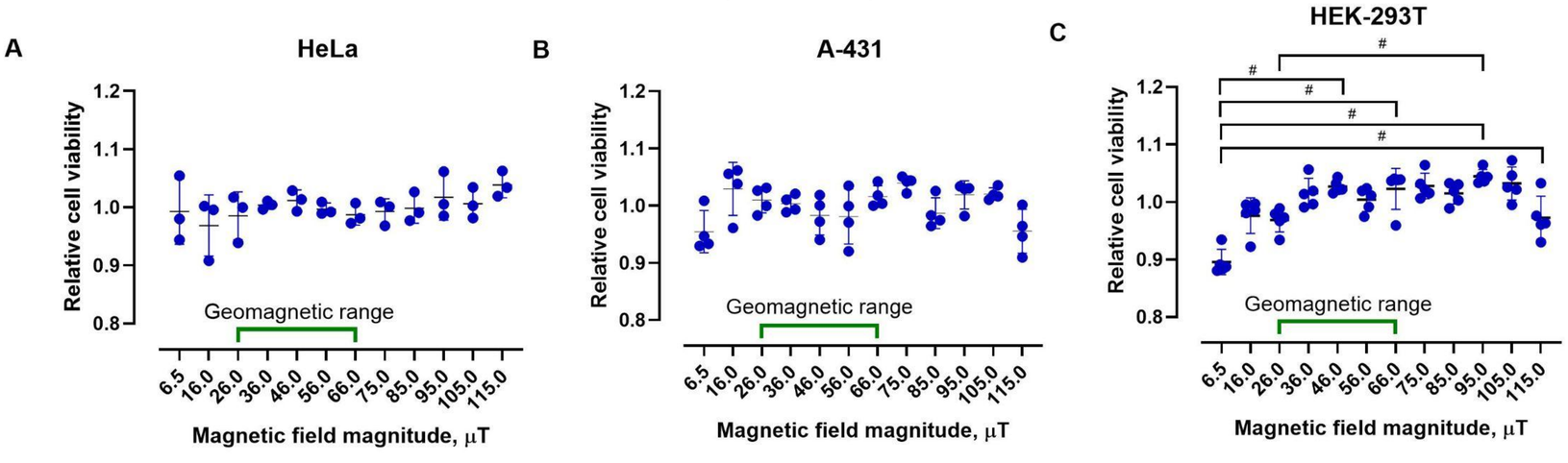


Figure 3. Growth of HeLa (A), A-431 (B), and HEK-293T (C) cells under a uniform MF of 48 ± 3 µT. Numbers 1–12 indicate columns in a 96-well culture plate. Data were normalized to the mean value of each independent experiment; individual dots represent independent experiments.



Cell Growth under WMFs of Different Intensities

When cells were exposed to MF intensities ranging from 6.5 µT to 115 µT, tumor cell cultures showed no statistically significant differences in growth rate across the tested MF intensities. In contrast, exposure to different MF intensities markedly altered the proliferation rate of HEK-293T cells. These cells were most sensitive to reduced MF intensity compared with the natural geomagnetic background, with the strongest decrease in proliferation observed at 6.5 µT.

Figure 4. Growth of HeLa (A), A-431 (B), and HEK-293T (C) cells exposed to MF intensities ranging from 6.5 µT to 115 µT. Data were normalized to the mean value of each independent experiment; individual dots represent independent experiments. # indicates statistical significance according to Dunn's test, $p < 0.05$.

Effect of Serum Deprivation on Sensitivity to WMFs of Different Intensities

Serum deprivation did not sensitize HeLa cells to MF exposure but increased variability in cell growth, which may indicate cellular stress. A-431 cells also showed increased variability and a non-significant tendency toward reduced growth at the boundary values of the tested MF intensity range. In line with previous findings, HEK-293T cells were the most sensitive to changes in MF intensity: the decrease in proliferation became more pronounced at 6.5 and 115 µT, indicating sensitivity to both extremes of the tested weak MF intensity range.

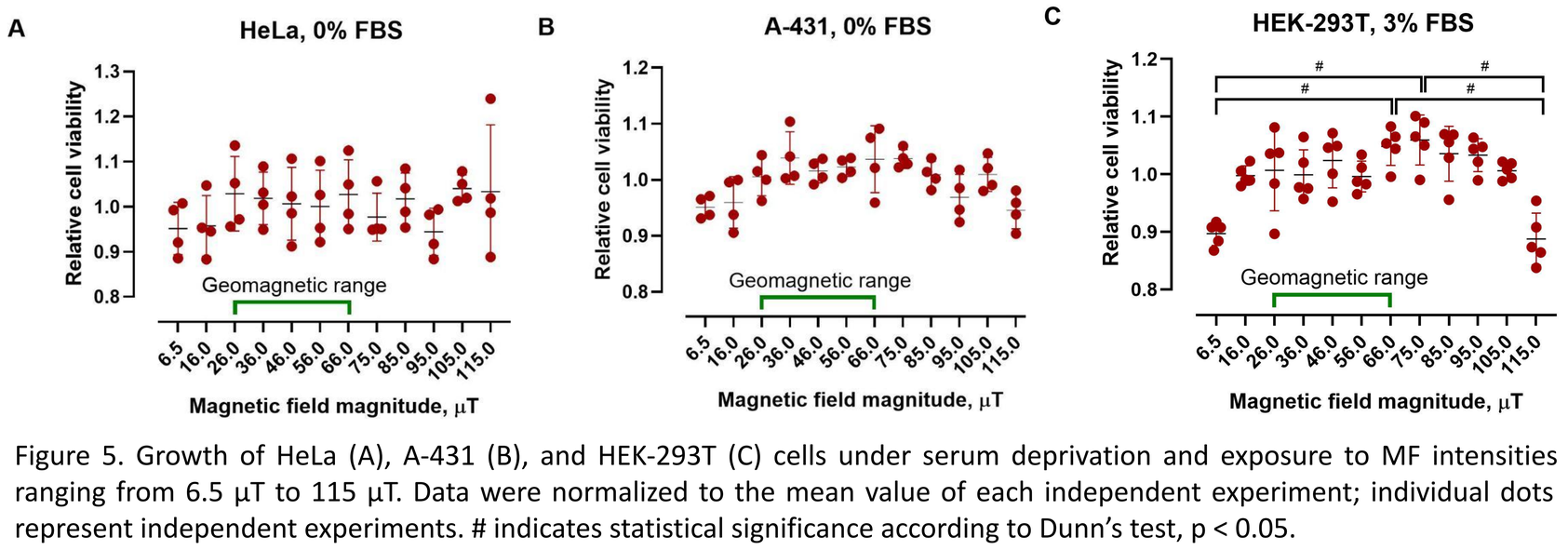


Figure 5. Growth of HeLa (A), A-431 (B), and HEK-293T (C) cells under serum deprivation and exposure to MF intensities ranging from 6.5 µT to 115 µT. Data were normalized to the mean value of each independent experiment; individual dots represent independent experiments. # indicates statistical significance according to Dunn's test, $p < 0.05$.

CONCLUSIONS

Proliferation of HEK-293T cells was dependent on MF intensity, and this effect was enhanced under stress conditions. No significant effects were observed in HeLa and A-431 cell lines, and this pattern persisted under serum deprivation. Tumor cells are known to exhibit pronounced metabolic and redox heterogeneity. It is suggested that MFs influence the cellular redox balance. The lack of effect in HeLa and A-431 may reflect the predominance of subpopulations in these lines that are adapted to oxidative stress.

ACKNOWLEDGMENT

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