Comment

Comment on Li, Y.; Héroux, P. Magnetic Fields Trump Oxygen in Controlling the Death of Erythro-Leukemia Cells. *Appl. Sci.* **2019**, *9*, 5318

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Li and Héroux [1] study the effects of 60 Hz, 1 μ T magnetic fields on necrosis and apoptosis of human cancer cells and find that transitions in this field enhance cell death.

At 50 μ T, the Earth's magnetic field is much higher in intensity than the study field. Since life has evolved in this magnetic environment, it is very unlikely that such weak fields can have any deleterious effect on biological processes. The fact that the study field varies at 60 Hz (as opposed to the Earth's largely static field) cannot have a significant effect due to the low frequency of the radiation. This is made evident by the fact that simply walking on the surface of the Earth induces varying magnetic fields of approximately 4 μ T [2]. Furthermore, 60 Hz magnetic fields of this strength generate intra-cellular electric fields with a strength that is 20 times smaller than the electric fields generated by intracellular thermal noise [2].

One must conclude that it is extremely unlikely that the fields used in this study can have any substantive biological effect. In fact, the rates of necrosis and apoptosis reported by the authors in their Table 1 (Table S1) indicate necrosis rates of approximately 0.5% regardless of the presence of the magnetic field and total apoptosis rates of approximately 13%, again with no statistically significant dependence on the presence of the magnetic field. It is only when "transitions" (moving a culture from one test environment to another) are examined that the authors find a statistical effect. Given the lack of plausible biological influences of the very weak magnetic field used in the study, one must speculate that the cause of the observed effect is due to other factors, such as stress induced in the transition itself. Thus, the extensive speculation concerning deleterious health effects of weak magnetic fields appears unjustified. This is strengthened by the fact that the increase in necrosis is observed when the magnetic field is both increased and decreased. Attempts to impute causal factors can be improved by establishing a dose response, perhaps by varying the strength of the magnetic field and the length of time in each test environment. In addition, the fact that diagonal entries in Table 3 (Table S2) are exactly one implies that experimental control groups were not created. Doing so will improve the robustness of the conclusions.

Supplementary Materials: The following are available online at <https://www.mdpi.com/article/10.3390/app11188391/s1>, Table S1: Cell Analyzer separation according to necrosis, and early or late apoptosis; Table S2: Triplicate relative necrosis, early apoptosis, and late apoptosis death results relative to baselines $\pm$ SD for all Transitions. Assuming normal distributions, 56% of the 36 mean/SD ratios individually reach $p < 0.05$, and 89% $p < 0.13$ against the null hypothesis.

Funding: This research received no external funding.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Li, Y.; Héroux, P. Magnetic Fields Trump Oxygen in Controlling the Death of Erythro-Leukemia Cells. *Appl. Sci.* **2019**, *9*, 5318. [[CrossRef](#)]
2. Adair, R. Constraints on biological effects of weak extremely-low-frequency electromagnetic fields. *Phys. Rev.* **1991**, *A43*, 1039. [[CrossRef](#)] [[PubMed](#)]

Citation: Swanson, E.S. Comment on Li, Y.; Héroux, P. Magnetic Fields Trump Oxygen in Controlling the Death of Erythro-Leukemia Cells. *Appl. Sci.* **2019**, *9*, 5318. *Appl. Sci.* **2021**, *11*, 8391. <https://doi.org/10.3390/app11188391>

Academic Editor: Roger Narayan

Received: 24 February 2020

Accepted: 6 September 2021

Published: 10 September 2021

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