

## HHS RF/EMF — EVIDENCE REVIEW REGISTER

Status

Recovered rows

Interpretation

RF vs ELF

Funding disclosure

Primary links

Evidence directions

Corrigenda

Links: 'Click to open source' uses st

ER

Working evidence inventory; not a systematic review or final risk-of-bias audit.

100 Yakymenko + 43 supplementary redox + 63 mitochondrial records = 206 records.

Counts are register records, not independent causal human findings; overlap and source verification

Mitochondrial register includes 30 direct RF, 18 ELF/PEMF and 15 indirect/special entries; do not

Funding provenance for most individual studies is NOT independently audited. Do not label incorrect

Some Yakymenko links are PubMed search queries rather than direct article records.

Preserve null, positive, mixed and beneficial findings. Selected studies include systematic reviews

Animal cancer Mevissen 2025 has 2026 corrigendum; pregnancy Cordelli 2023 has 2025 corrigendum

The concise and full research submissions refer to this register for supporting sources and verification

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[illegible]

[illegible]

[illegible]

|         |                        |                               |
|---------|------------------------|-------------------------------|
| NEW-037 | Supplementary redox 43 | RF (as classified in register |
| NEW-038 | Supplementary redox 43 | RF (as classified in register |
| NEW-039 | Supplementary redox 43 | RF (as classified in register |
| NEW-040 | Supplementary redox 43 | RF (as classified in register |
| NEW-041 | Supplementary redox 43 | RF (as classified in register |
| NEW-042 | Supplementary redox 43 | RF (as classified in register |
| NEW-043 | Supplementary redox 43 | RF (as classified in register |
| MIT-021 | Mitochondrial 63       | RF / microwave                |
| MIT-025 | Mitochondrial 63       | RF / microwave                |
| MIT-027 | Mitochondrial 63       | RF / microwave                |
| MIT-028 | Mitochondrial 63       | RF / microwave                |
| MIT-029 | Mitochondrial 63       | RF / microwave                |
| MIT-030 | Mitochondrial 63       | RF / microwave                |
| MIT-031 | Mitochondrial 63       | RF / microwave                |
| MIT-032 | Mitochondrial 63       | RF / microwave                |
| MIT-033 | Mitochondrial 63       | RF / microwave                |
| MIT-034 | Mitochondrial 63       | RF / microwave                |
| MIT-035 | Mitochondrial 63       | RF / microwave                |
| MIT-036 | Mitochondrial 63       | RF / microwave                |
| MIT-037 | Mitochondrial 63       | RF / microwave                |
| MIT-039 | Mitochondrial 63       | RF / microwave                |
| MIT-040 | Mitochondrial 63       | RF / microwave                |
| MIT-041 | Mitochondrial 63       | RF / microwave                |
| MIT-042 | Mitochondrial 63       | RF / microwave                |
| MIT-043 | Mitochondrial 63       | RF / microwave                |
| MIT-044 | Mitochondrial 63       | RF / microwave                |
| MIT-045 | Mitochondrial 63       | RF / microwave                |
| MIT-046 | Mitochondrial 63       | RF / microwave                |
| MIT-048 | Mitochondrial 63       | RF / microwave                |
| MIT-050 | Mitochondrial 63       | RF / microwave                |
| MIT-052 | Mitochondrial 63       | RF / microwave                |
| MIT-053 | Mitochondrial 63       | RF / microwave                |
| MIT-055 | Mitochondrial 63       | RF / microwave                |
| MIT-056 | Mitochondrial 63       | RF / microwave                |
| MIT-057 | Mitochondrial 63       | RF / microwave                |
| MIT-061 | Mitochondrial 63       | RF / microwave                |
| MIT-062 | Mitochondrial 63       | RF / microwave                |
| MIT-001 | Mitochondrial 63       | ELF / PEMF (distinct)         |
| MIT-002 | Mitochondrial 63       | ELF / PEMF (distinct)         |
| MIT-003 | Mitochondrial 63       | ELF / PEMF (distinct)         |
| MIT-004 | Mitochondrial 63       | ELF / PEMF (distinct)         |
| MIT-005 | Mitochondrial 63       | ELF / PEMF (distinct)         |
| MIT-006 | Mitochondrial 63       | ELF / PEMF (distinct)         |
| MIT-007 | Mitochondrial 63       | ELF / PEMF (distinct)         |
| MIT-008 | Mitochondrial 63       | ELF / PEMF (distinct)         |
| MIT-009 | Mitochondrial 63       | ELF / PEMF (distinct)         |

|         |                  |                               |
|---------|------------------|-------------------------------|
| MIT-010 | Mitochondrial 63 | ELF / PEMF (distinct)         |
| MIT-011 | Mitochondrial 63 | ELF / PEMF (distinct)         |
| MIT-012 | Mitochondrial 63 | ELF / PEMF (distinct)         |
| MIT-014 | Mitochondrial 63 | ELF / PEMF (distinct)         |
| MIT-015 | Mitochondrial 63 | ELF / PEMF (distinct)         |
| MIT-016 | Mitochondrial 63 | ELF / PEMF (distinct)         |
| MIT-017 | Mitochondrial 63 | ELF / PEMF (distinct)         |
| MIT-018 | Mitochondrial 63 | ELF / PEMF (distinct)         |
| MIT-020 | Mitochondrial 63 | ELF / PEMF (distinct)         |
| MIT-022 | Mitochondrial 63 | Indirect / special (distinct) |
| MIT-013 | Mitochondrial 63 | Indirect / special (distinct) |
| MIT-023 | Mitochondrial 63 | Indirect / special (distinct) |
| MIT-024 | Mitochondrial 63 | Indirect / special (distinct) |
| MIT-026 | Mitochondrial 63 | Indirect / special (distinct) |
| MIT-038 | Mitochondrial 63 | Indirect / special (distinct) |
| MIT-047 | Mitochondrial 63 | Indirect / special (distinct) |
| MIT-049 | Mitochondrial 63 | Indirect / special (distinct) |
| MIT-051 | Mitochondrial 63 | Indirect / special (distinct) |
| MIT-054 | Mitochondrial 63 | Indirect / special (distinct) |
| MIT-058 | Mitochondrial 63 | Indirect / special (distinct) |
| MIT-059 | Mitochondrial 63 | Indirect / special (distinct) |
| MIT-060 | Mitochondrial 63 | Indirect / special (distinct) |
| MIT-019 | Mitochondrial 63 | Indirect / special (distinct) |
| MIT-063 | Mitochondrial 63 | Indirect / special (distinct) |

| Authors / year        | Model / specimen                   | Carrier / field |
|-----------------------|------------------------------------|-----------------|
| Pilla (2012)          | Neuronal cells / human fibroblasts | 27.12           |
| Tkalec (2007)         | Duckweed                           | 400             |
| Ferreira (2006a)      | Rat                                | 800             |
| Hook (2004)           | Mammalian cells in vitro           | 835.62          |
| Bilgici (2013)        | Rat                                | 850             |
| Friedman (2007)       | HeLa membrane                      | 875             |
| Meral (2007)          | Guinea pig                         | 890             |
| Ayata (2004)          | Rat                                | 900             |
| Burlaka (2013)        | Quail embryo                       | 900             |
| Campisi (2010)        | Rat astroglial cells               | 900             |
| Cenesiz (2011)        | Guinea pig                         | 900             |
| Cetin (2014)          | Pregnant rat and offspring         | 900             |
| Dasdag (2008)         | Rat                                | 900             |
| Dasdag (2009)         | Rat                                | 900             |
| Dasdag (2012)         | Rat                                | 900             |
| Deshmukh (2013)       | Rat                                | 900             |
| Esmekaya (2011)       | Rat                                | 900             |
| Guney (2007)          | Rat                                | 900             |
| Ilhan (2004)          | Rat                                | 900             |
| Jelodar (2013a)       | Rat eyes                           | 900             |
| Jelodar (2013b)       | Rat testes                         | 900             |
| Kahya (2014)          | Cancer cell cultures               | 900             |
| Kerman & Senol (2012) | Rat                                | 900             |
| Kesari (2011)         | Rat                                | 900             |
| Koylu (2006)          | Rat                                | 900             |
| Koyu (2009)           | Rat                                | 900             |
| Lu (2012)             | Human blood mononuclear cells      | 900             |
| Luo (2014)            | Rat                                | 900             |
| Mailankot (2009)      | Rat                                | 900             |
| Marzook (2014)        | Rat                                | 900             |
| Megha (2012)          | Rat                                | 900             |
| Oktem (2005)          | Rat                                | 900             |
| Oral (2006)           | Rat                                | 900             |
| Ozguner (2005a)       | Rat                                | 900             |
| Ozguner (2005b)       | Rat                                | 900             |
| Ozguner (2006)        | Rat                                | 900             |
| Ragy (2014)           | Rat                                | 900             |
| Saikhedkar (2014)     | Rat                                | 900             |
| Sharma (2009)         | Mung bean                          | 900             |
| Singh (2012)          | Mung bean                          | 900             |
| Sokolovic (2013)      | Rat                                | 900             |
| Tkalec (2013)         | Earthworm                          | 900             |
| Tsybulin (2012)       | Quail embryos                      | 900             |
| Türedi (2014)         | Rat pups                           | 900             |

|                           |                             |        |
|---------------------------|-----------------------------|--------|
| Özorak (2013)             | Rat                         | 900    |
| Zmyślony (2004)           | Rat lymphocytes             | 930    |
| Sefidbakht (2014)         | HEK293T cells               | 940    |
| Yurekli (2006)            | Rat                         | 945    |
| Furtado-Filho (2014)      | Rat pups                    | 950    |
| Abu Khadra (2014)         | Human participant           | 1800   |
| Avci (2012)               | Rat                         | 1800   |
| Bodera (2013)             | Rat                         | 1800   |
| De Iuliis (2009)          | Human sperm in vitro        | 1800   |
| Guler (2012)              | Infant rabbit               | 1800   |
| Hou (2014)                | Mouse embryonic fibroblast  | 1800   |
| Khalil (2012)             | Rat                         | 1800   |
| Kismali (2012)            | Rabbit                      | 1800   |
| Liu (2013b)               | GC-2 cells                  | 1800   |
| Marjanovic (2014)         | V79 cells                   | 1800   |
| Ni (2013)                 | Human lens epithelial cells | 1800   |
| Ozgur (2010)              | Guinea pig                  | 1800   |
| Ozgur (2013)              | Rabbit                      | 1800   |
| Qin (2014)                | Mouse                       | 1800   |
| Tomruk (2010)             | Rabbit                      | 1800   |
| Xu (2010)                 | Primary cultured neurons    | 1800   |
| Manta (2013)              | Drosophila                  | 1880   |
| Kumar (2014)              | Rat                         | 1910.5 |
| Kesari (2013)             | Rat                         | 2115   |
| Aynali (2013)             | Rat                         | 2450   |
| Gürler (2014)             | Rat                         | 2450   |
| Lai & Singh (1997)        | Rat                         | 2450   |
| Meena (2013)              | Rat                         | 2450   |
| Naziroglu (2012a)         | Rat                         | 2450   |
| Naziroglu (2012b)         | HL-60 cells                 | 2450   |
| Naziroglu & Gumral (2009) | Rat                         | 2450   |
| Oksay (2014)              | Rat                         | 2450   |
| Shahin (2013)             | Mouse                       | 2450   |
| Turker (2011)             | Rat                         | 2450   |
| Tök (2014)                | Rat                         | 2450   |
| Garaj-Vrhovac (2011)      | Human participant           | 3000   |
| Agarwal (2009)            | Human sperm in vitro        | None   |
| Akbari (2014)             | Rat                         | None   |
| Al-Damegh (2012)          | Rat                         | None   |
| Balci (2007)              | Rat                         | None   |
| Burlaka (2014)            | Rat                         | None   |
| Dasdag (2003)             | Rat                         | None   |
| de Souza (2014)           | Human participant           | None   |
| Demirel (2012)            | Rat                         | None   |
| Ferreira (2006b)          | Pregnant rat                | None   |
| Hamzany (2013)            | Human participant           | None   |

|                                |                                  |                 |
|--------------------------------|----------------------------------|-----------------|
| Jing (2012)                    | Pregnant rat                     | None            |
| Kesari (2010)                  | Male rat                         | None            |
| Khalil (2014)                  | Human participant                | None            |
| Koc (2013)                     | Rat                              | None            |
| Lantow (2006a)                 | Human blood cells                | None            |
| Lantow (2006b)                 | Human Mono Mac 6 and K562        | None            |
| Motawi (2014)                  | Rat                              | None            |
| Moustafa (2001)                | Human participant                | None            |
| Sokolovic (2008)               | Rat                              | None            |
| Suleyman (2004)                | Rat                              | None            |
| Chow et al. (2024)             | Human endothelial cells (HUVEC)  | 6.78            |
| Alkış et al. (2019)            | Rats, brain and blood            | 900, 1800, 2100 |
| Diabetes/liver study (201      | Rats, liver                      | 900             |
| Fetal-liver study (2023)       | Rats, fetal liver                | 900             |
| Hancı et al. (2018)            | Male rats, testis                | 900             |
| Hancı et al. (2018)            | Male rats, sciatic nerve         | 900             |
| Honey-bee exposure study       | Honeybees, workers               | 900             |
| Nazıroğlu et al. (2018)        | Rats, hippocampus and dorsal-r   | 900, 1800       |
| Prenatal/postnatal study       | Rats, offspring brain and kidney | 900             |
| Sharma, Bahel & Katnoria       | Fenugreek plants                 | 900             |
| Vilić et al. (2024)            | Honeybees, larvae/pupae/adults   | 900             |
| Cardiac metabolic profile      | Mice, heart                      | 915             |
| Hurtier et al. (2025)          | Human skin fibroblasts and cort  | 1800, 3500      |
| Jangid et al. (2024)           | Mouse Leydig TM3 cells           | 1800, 2450      |
| Jangid et al. (2026)           | Mouse Leydig TM3 cells           | 1800, 2450      |
| Jangid et al. (Oct 2026)       | Mouse Leydig TM3 cells           | 1800, 2450      |
| Marjanović Cermak et al.       | Human-derived cultured cells     | 1800            |
| Marjanović Cermak et al.       | Human neuroblastoma (SH-SY5Y)    | 1800            |
| Schuermann and colleagues      | Human HEK293 cells               | 1800            |
| Schuermann et al. (2022)       | Human HEK293 cells               | 1800            |
| Shahin et al. (2018)           | Mice, testis                     | 1800            |
| Sharma, Bahel & Katnoria       | Onion plants                     | 1800, 2400      |
| Xu et al. (2013)               | Human/rodent cell lines          | 1800            |
| Sannino et al. (2009)          | Human Jurkat lymphoblastoid cell | 1950            |
| Sannino et al. (2023)          | Hamster lung V79 cells           | 1950            |
| Sannino et al. (2024)          | Human neuroblastoma SH-SY5Y cell | 1950            |
| Wi-Fi pancreatic islet st      | Rats, pancreas                   | 2450            |
| Arabidopsis low-intensity      | Arabidopsis plants               | 2450            |
| Behavioral/brain study (2      | Rats, brain                      | 2450            |
| Gupta & Srivastava (2022)      | Domestic chickens, male          | 2450            |
| HEK293 zinc protective st      | Human HEK293 cells               | 2450            |
| Kamali et al. (2018)           | Rats, plasma                     | 2450            |
| Kuybulu et al. (2016)          | Rats, kidney                     | 2450            |
| Rat myocardial study (201      | Rats, heart                      | 2450            |
| Sulforaphane cell study (Human | SH-SY5Y and peripheral bl        | 2450            |
| Vijay et al. (2025)            | Rats, testes/sperm               | 2450            |

|                                                          |              |
|----------------------------------------------------------|--------------|
| Wistar whole-body study (Rats, brain/liver/spleen        | 2450         |
| Çelik et al. (2016) Rats and offspring, brain/liver      | 2450         |
| 5G UV-redox experiment (2Human keratinocytes, mouse mela | 3500, 28000  |
| Bektas et al. (2026) Mouse primary sensory neurons       | 3500         |
| Haidar et al. (2025) Human fibroblasts and HaCaT cel     | 3500         |
| Patrignoni et al. (2024) Human fibroblasts, keratinocyte | 3500         |
| Residents near base statiHuman volunteers (24 adults)    | UNSPECIFIED  |
| (2023) investigators Human fibrosarcoma and fibrobla     | 4.2 MHz      |
| (2024) investigators Boar spermatozoa in vitro           | 700 MHz      |
| Capri et al. Human blood mononuclear cells i             | 900 MHz      |
| Aitken et al. Mouse epididymal sperm                     | 900 MHz      |
| Falzone et al. Human spermatozoa in vitro                | 900 MHz      |
| Sun et al. Human HL-60 cells                             | 900 MHz      |
| Pandey et al. Male Swiss albino mice                     | 900 MHz      |
| Sun et al. Human HL-60 cells                             | 900 MHz      |
| Gupta et al. Rat hippocampus; 900, 1800 and              | 900 MHz      |
| Nazıroğlu et al. Rat hippocampal and dorsal-root         | 900 MHz      |
| (2023) investigators C57BL/6J mice; adipose              | 900 MHz      |
| Houston et al. Male mice; epididymal sperm               | 905 MHz      |
| (2023) investigators Mice; heart mitochondria            | 915 MHz      |
| (2019) investigators Human and rat primary astrocyte     | 918 MHz      |
| Ducray et al. Human SH-SY5Y neuroblastoma-der            | 935 MHz      |
| (2004) investigators Human peripheral blood mononucl     | 1800 MHz     |
| De Iuliis et al. Purified human spermatozoa in v         | 1800 MHz     |
| Xu et al. Rat cortical neurons in vitro                  | 1800 MHz     |
| (2016) investigators Mouse NIH/3T3 and human U-87 MG     | 1800 MHz     |
| Houston et al. Mouse GC-1/GC-2 cells and sperm           | 1800 MHz     |
| Li et al. Mouse NIH/3T3 fibroblasts                      | 1800 MHz     |
| Hurtier et al. Rat cortical neurons and human            | 1800 MHz     |
| Jangid et al. Mouse TM3 Leydig cells                     | 1800 MHz     |
| (2023) investigators Human SH-SY5Y cells; human PBMC     | 2450 MHz     |
| (2024) investigators Mouse liver isolated mitochondr     | 2450 MHz     |
| Sueiro-Benavides et al. Mouse RAW264.7 macrophages       | 2450 MHz     |
| Patrignoni et al. Human fibroblasts, keratinocyte        | 3500 MHz     |
| Haidar et al. Human XP6BE fibroblasts; HaCaT             | 3500 MHz     |
| Soran et al. Parsley, celery, dill                       | Not reported |
| Li et al. Primary rat chondrocytes in cul                | Not reported |
| Ito et al. Human-derived NARP cybrids carr               | 4 Hz         |
| Yang et al. Human umbilical vein endothelia              | 40 Hz        |
| Schmitz et al. Adult mice brain/kidney                   | 50 Hz        |
| Pilger et al. Human diploid fibroblasts                  | 50 Hz        |
| Bernabò et al. Boar spermatozoa                          | 50 Hz        |
| Khaki et al. Rat prostate gland                          | 50 Hz        |
| Iorio et al. Human spermatozoa                           | 50 Hz        |
| Luukkonen et al. Human SH-SY5Y cells                     | 50 Hz        |
| Destefanis et al. Human cancer cell lines                | 50 Hz        |

|                      |                                 |              |
|----------------------|---------------------------------|--------------|
| Feng et al.          | Human amniotic epithelial cells | 50 Hz        |
| Falone et al.        | Human neuroblastoma cells       | 50 Hz        |
| Feng et al.          | Human FL amniotic cells         | 50 Hz        |
| (2020) investigators | Mouse RAW264.7 macrophages      | 50 Hz        |
| (2022) investigators | Human breast cancer and nonmali | 50 Hz        |
| (2024) investigators | Senescent human fetal lung fibr | 50 Hz        |
| Liao et al.          | Mouse L929 fibroblasts          | 80 Hz        |
| Osera et al.         | Human neuroblastoma cells       | Not reported |
| Ivanov et al.        | BALB/c mice thymocytes          | Not reported |
| Curley et al.        | Human pancreatic cancer cells   | 13.56 MHz    |
| Solek et al.         | Mouse GC-1 and GC-2 cells       | 50 Hz        |
| (1984) investigators | Rats / brain                    | 200 MHz      |
| (1981) investigators | Rats / brain                    | 591 MHz      |
| Agarwal et al.       | Human ejaculated sperm in vitro | 850 MHz      |
| Arendash et al.      | Transgenic Alzheimer mice and   | 18 MHz       |
| Sun et al.           | Mouse embryonic fibroblasts wit | 1800 MHz     |
| Jangid et al.        | TM3 mouse Leydig cells          | 1800 MHz     |
| Falone et al.        | Human SH-SY5Y neuroblastoma cel | 1950 MHz     |
| (2026) investigators | HeLa cells                      | 2450 MHz     |
| (2014) investigators | Rat testes                      | 10000 MHz    |
| Rahimi et al.        | Sprague-Dawley rats treated wit | 28000 MHz    |
| Beneduci et al.      | Human MCF-7 cells               | 52000 MHz    |
| Falone et al.        | Human SK-N-BE(2) neuroblastoma  | Not reported |
| Hagras et al.        | Human observational semen study | Not reported |

| Waveform                      | Biological endpoint               |
|-------------------------------|-----------------------------------|
| Pulsed (explicit)             | Reactive nitrogen species / indir |
| Not documented in review tab  | Direct ROS / ROS-associated radic |
| Phone source; specific wavef  | Null oxidative marker finding     |
| FMCW / CDMA (two modulated si | Null oxidative marker finding     |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Not documented in review tab  | ROS-generating enzyme activity (i |
| Phone source; specific wavef  | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| GSM modulated (reported)      | Direct ROS / ROS-associated radic |
| CW and modulated / pulsed (b  | Direct ROS / ROS-associated radic |
| Environmental RF; waveform ur | Null oxidative marker finding     |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Phone source; specific wavef  | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Pulsed + modulated (explicit) | Indirect oxidative biomarker / re |
| Not documented in review tab  | Null oxidative marker finding     |
| Phone source; specific wavef  | Null oxidative marker finding     |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Pulsed (explicit)             | Direct ROS / ROS-associated radic |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Not documented in review tab  | Direct ROS / ROS-associated radic |
| Phone source; specific wavef  | Indirect oxidative biomarker / re |
| GSM modulated (reported)      | Indirect oxidative biomarker / re |
| Environmental RF; waveform ur | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Not documented in review tab  | Null oxidative marker finding     |
| Not documented in review tab  | Null oxidative marker finding     |
| Phone source; specific wavef  | Null oxidative marker finding     |
| Phone source; specific wavef  | Indirect oxidative biomarker / re |
| Phone source; specific wavef  | Indirect oxidative biomarker / re |
| Phone source; specific wavef  | Direct ROS / ROS-associated radic |
| Phone source; specific wavef  | Direct ROS / ROS-associated radic |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| GSM modulated (reported)      | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |

|                               |                                   |
|-------------------------------|-----------------------------------|
| Pulsed (explicit)             | Indirect oxidative biomarker / re |
| Not documented in review tab  | Direct ROS / ROS-associated radic |
| Not documented in review tab  | Direct ROS / ROS-associated radic |
| GSM modulated (reported)      | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| GSM modulated (reported)      | Indirect oxidative biomarker / re |
| Not documented in review tab  | Null oxidative marker finding     |
| GSM modulated (reported)      | Indirect oxidative biomarker / re |
| Not documented in review tab  | Direct ROS / ROS-associated radic |
| GSM modulated (reported)      | Indirect oxidative biomarker / re |
| GSM modulated (reported)      | Direct ROS / ROS-associated radic |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| GSM modulated (reported)      | Direct ROS / ROS-associated radic |
| Not documented in review tab  | Direct ROS / ROS-associated radic |
| Not documented in review tab  | Direct ROS / ROS-associated radic |
| GSM modulated (reported)      | Indirect oxidative biomarker / re |
| Pulsed (explicit)             | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| GSM modulated (reported)      | Indirect oxidative biomarker / re |
| Pulsed (explicit)             | Indirect oxidative biomarker / re |
| DECT modulated (reported)     | Direct ROS / ROS-associated radic |
| Phone source; specific wavef  | Indirect oxidative biomarker / re |
| Not documented in review tab  | Direct ROS / ROS-associated radic |
| Pulsed (explicit)             | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Pulsed (explicit)             | Indirect oxidative biomarker / re |
| Not documented in review tab  | Direct ROS / ROS-associated radic |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Pulsed (explicit)             | Indirect oxidative biomarker / re |
| Not documented in review tab  | Indirect oxidative biomarker / re |
| Pulsed (explicit)             | Indirect oxidative biomarker / re |
| Not documented in review tab  | Direct ROS / ROS-associated radic |
| Pulsed (explicit)             | Indirect oxidative biomarker / re |
| Wi-Fi modulated (source repo  | Indirect oxidative biomarker / re |
| Pulsed (explicit)             | Indirect oxidative biomarker / re |
| Phone source; specific wavef  | Direct ROS / ROS-associated radic |
| Environmental RF; waveform ur | Indirect oxidative biomarker / re |
| Phone source; specific wavef  | Indirect oxidative biomarker / re |
| Phone source; specific wavef  | Indirect oxidative biomarker / re |
| CW and modulated / pulsed (b  | Direct ROS / ROS-associated radic |
| Phone source; specific wavef  | Null oxidative marker finding     |
| Phone source; specific wavef  | Null oxidative marker finding     |
| 3G source (modulation paramet | Null oxidative marker finding     |
| Phone source; specific wavef  | Null oxidative marker finding     |
| Phone source; specific wavef  | Indirect oxidative biomarker / re |

Phone source; specific wavefIndirect oxidative biomarker / re  
Phone source; specific wavefIndirect oxidative biomarker / re  
Phone source; specific wavefNull oxidative marker finding  
Phone source; specific wavefIndirect oxidative biomarker / re  
CW and modulated / pulsed (bDirect ROS / ROS-associated radic  
CW and modulated / pulsed (bIndirect oxidative biomarker / re  
Phone source; specific wavefIndirect oxidative biomarker / re  
Phone source; specific wavefIndirect oxidative biomarker / re  
Phone source; specific wavefIndirect oxidative biomarker / re  
Phone source; specific wavefIndirect oxidative biomarker / re  
Research RF; modulation not Direct ROS/redox  
Lab RF generator; waveform nIndirect oxidation/DNA damage  
GSM antenna emissions; modulæIndirect oxidative markers  
GSM 900 MHz; modulated sourceIndirect lipid oxidation/enzymes  
900 MHz continuous exposure; Indirect oxidative markers  
900 MHz continuous exposure; Indirect oxidative markers  
Controlled field; modulation Antioxidant-associated indirect o  
900/1800 MHz experimental expDirect/indirect ROS oxidative mar  
RF exposure; waveform not veIndirect oxidant/antioxidant stat  
RF source; modulation not veIndirect lipid oxidation/enzymes  
Base-station field; environmæIndirect lipid oxidation/enzymes  
Experimental 915 MHz RF; wavæNull antioxidant/proxy assessment  
GSM- and 5G-modulated, explicDirect ROS, null  
4G mobile + 1800/2450 generatDirect ROS  
4G handset + 1800/2450 generæDirect superoxide/NO  
4G handset + 1800/2450 generæDirect ROS with mitochondrial mar  
Laboratory RF source; wavefoiROS/oxidation investigation  
GTEM 1800 MHz; waveform not Direct ROS and indirect oxidation  
Single-frequency RF carrier; Gene expression / ROS inference  
Single carrier; no communicatDirect ROS  
Mobile-phone dialing/receivirDirect ROS plus indirect  
RF exposure; modulation not Direct redox/enzymes  
GSM-like pulse modulation, 2Direct ROS, null  
UMTS 1950 MHz; modulated Direct ROS, null  
Both LTE-modulated and unmodDirect ROS, null/mixed  
UMTS-modulated 1950 MHz Oxidative DNA damage, protective  
Wi-Fi communication signal, Indirect lipid oxidation/enzymes  
Unmodulated continuous wave Indirect oxidation/enzymes  
2.45 GHz generator; waveform Indirect lipid oxidation/enzymes  
Microwave RF; waveform not veIndirect oxidative biomarkers  
2.45 GHz experimental RF; modIndirect lipid oxidation/enzymes  
Wi-Fi traffic; continuous duIndirect antioxidants; mixed endp  
Wireless device-like exposureIndirect lipid oxidation/enzymes  
High-intensity microwave; wavIndirect lipid oxidation/enzymes  
2.45 GHz experimental RF; modDirect ROS plus mitochondrial mar  
Wi-Fi 2.45 GHz; modulated Indirect lipid oxidation

Generator 2450 MHz; waveform Indirect lipid oxidation  
 Wi-Fi-type source, modulated Indirect lipid oxidation/enzymes  
 5G-modulated 3.5 and 28 GHz Direct ROS, reduction with co-exp  
 Pulsed GSM-like 217 Hz 12.5% Direct ROS  
 5G-modulated 3500 MHz Direct ROS, null  
 5G-modulated 3500 MHz Direct mitochondrial ROS, mixed  
 Mixed environmental base-sta Oxidative status, human observati  
 RF field; waveform details nd Mitochondrial respiration, mass;  
 Continuous RF at individual Mitochondrial membrane potential  
 CW and GSM modulated arms Mitochondrial membrane potential  
 CW (EMF-Portal exposure extra Mitochondrial DNA integrity  
 Pulsed GSM Mitochondrial membrane potential  
 Not verified Mitochondrial membrane potential,  
 Pulsed exposure (review chara Mitochondrial membrane potential  
 Continuous wave (CW) mtDNA 8-OHdG, copy number, TFAM,  
 Exposure modulation not veri Mitochondrial integrity/function;  
 Cell phone-related RF; wavef Mitochondrial JC-1 depolarization  
 Not verified Mitochondrial activity, mtDNA cop  
 Dedicated waveguide; waveform Mitochondrial ROS; oxidative nucl  
 Not verified OXPHOS complex proteins; respirat  
 Mobile-phone RF signal; deta Mitochondrial ROS and membrane po  
 Not verified Mitochondrial respiration; fissio  
 GSM Basic, DTX and Talk modul Mitochondrial membrane potential  
 Waveguide signal; modulation Mitochondrial ROS; mitochondrial  
 217 Hz pulse-modulated Mitochondrial 8-OHdG; mtDNA copy  
 Continuous 1800 MHz irradiati MitoSOX mitochondrial ROS; cytoch  
 Continuous wave (CW) Mitochondrial ROS; ETC complex II  
 Intermittent RF exposure (not Mitochondrial electron microscopy  
 GSM-modulated and 5G-modulat MitoSOX mitochondrial ROS  
 4G phone and RF signal genera Membrane potential (JC-1), ATP, R  
 Antenna radiation; waveform  $\Delta\Psi_m$ , NAD<sup>+</sup>/NADH, mtTFA, ROS, SOD1  
 Microwave; waveform not veri High-resolution respirometry S3/S  
 Not verified Mitochondrial activity; lysosome-  
 5G-modulated Mitochondrial ROS and membrane po  
 5G-modulated Mitochondria-targeted redox biose  
 GSM and WLAN exposure; modul Electron microscopy: mitochondria  
 Millimeter wave; specific fr Electron microscopy shows mitocho  
 Pulsed field modulated 1–8 Hz mtDNA transcripts, copy number, O  
 Pulsed ELF / PEMF OCR/ECAR; mitochondrial potential  
 50 Hz sinusoidal magnetic fie Mitochondrial DNA synthesis (radi  
 Intermittent 50 Hz JC-1 mitochondrial potential  
 50 Hz magnetic field Mitochondrial activity; motility  
 50 Hz magnetic field Mitochondrial ultrastructure  
 Square-wave ELF Mitochondrial membrane potential;  
 50 Hz magnetic field Mitochondrial activity; ROS  
 ELF field; waveform details u Mitochondrial activity and respir

|                               |                                                |
|-------------------------------|------------------------------------------------|
| 50 Hz magnetic field          | Mitochondrial permeability transi              |
| 50 Hz magnetic field          | Mitochondrial metabolism / biogen              |
| 50 Hz magnetic field          | Mitochondrial ROS; permeability t              |
| 50 Hz sinusoidal              | JC-1 mitochondrial membrane poten              |
| 50 Hz magnetic field          | Mitochondrial membrane potential;              |
| 50 Hz magnetic field          | Mitochondrial permeability transi              |
| Pulsed ELF / PEMF             | Mitochondrial stress test; potent              |
| Pulsed EMF, carrier parameter | Mitochondrial MnSOD activity (SOD              |
| Broadband pulsed therapeutic  | Mitochondrial fluorescence and pl              |
| Not verified                  | Mitochondrial cristae morphology;              |
| Pulsed vs continuous ELF conc | Apoptotic signaling, superoxide; ;             |
| Not verified                  | ATP, phosphocreatine; electron tr              |
| CW                            | Brain ATP, NADH, phosphocreatine               |
| Cell phone source; not verifi | ROS and motility; no mitochondria              |
| GSM pulsed / modulated        | References mitochondrial enhancem              |
| RF exposure; modulation not v | Mitochondrial MCU inhibition as m              |
| Mobile-phone RF plus 1800, 24 | Intracellular superoxide and NO; ;             |
| Not verified                  | Cell redox/antioxidant defenses; ;             |
| Not verified                  | Mitochondrial localization of adm              |
| Not verified                  | ROS; sperm cell-cycle arrest; mit              |
| 28 GHz RF; modulation not inc | BAX/caspase mitochondrial-pathway              |
| Wide-band millimeter-wave RF  | General cell ultrastructure; mito              |
| PEMF; carrier repetition to v | Mitochondria-related redox signal              |
| Real-world mobile telephony;  | Mitochondrial isoenzyme NAD <sup>+</sup> -depe |

## Reported finding

Nitric oxide increased  
H<sub>2</sub>O<sub>2</sub>/LPO increased  
No lipid/protein oxidative change  
No significant oxidative changes  
NO/MDA/protein oxidation increased  
NADH oxidase increased  
MDA increased, GSH lower  
MDA and enzyme changes  
Superoxide/NO/TBARS/8-OHdG increased  
ROS increased with modulation  
Oxidant status and NO changed  
GPx and antioxidant nutrient changes  
MDA / total oxidative status increased  
CAT / total antioxidant capacity increased  
Protein carbonyl increased  
LPO and protein oxidation increased  
MDA/NO<sub>x</sub> increased, GSH decreased  
MDA/NO increased, enzymes decreased  
MDA/NO increased; enzyme changes  
MDA increased, antioxidant enzymes lower  
MDA increased, enzyme activity lower  
Oxidative stress/apoptosis  
MDA increased, enzymes lower  
ROS increased, SOD/GPx decreased  
Brain LPO increased  
Liver LPO and enzymes increased  
ROS-mediated apoptosis  
MDA/Nrf2 increased; GSH/SOD lower  
LPO higher; GSH lower  
SOD/CAT decreased  
LPO/protein oxidation increased; GSH lower  
Renal MDA increased; enzymes lower  
Endometrial MDA increased  
Cardiac MDA/NO increased  
Renal MDA/NO increased  
Retinal MDA/NO increased  
MDA increased; antioxidants lower  
LPO increased; antioxidant changes  
Hydrogen peroxide/MDA increased  
H<sub>2</sub>O<sub>2</sub> and MDA increased  
Thymic LPO/protein oxidation increased  
Protein carbonyl/MDA increased  
TBARS increased  
MDA/enzymes altered

Kidney/testis LPO increased  
ROS increased with FeCl<sub>2</sub>  
ROS increased transiently  
MDA higher, GSH lower  
CAT/LPO decreased; genotoxicity  
Salivary SOD increased  
Protein oxidation and NO increased  
Antioxidant capacity decreased  
ROS increased  
LPO and 8-OHdG increased  
ROS increased  
Urinary 8-OHdG increased  
Creatine kinase changed (not direct ROS)  
ROS increased  
ROS changed  
ROS and MDA increased  
Liver MDA/NO<sub>x</sub> increased  
Prenatal LPO increased  
MDA increased, CAT/GPx decreased  
MDA/oxidation higher  
8-OHdG increased  
ROS increased including ovary  
LPO and DNA damage increased  
ROS and DNA damage increased  
LPO increased  
8-OHdG/protein oxidation increased  
Antioxidant/spin trapping blocked DNA damage  
MDA/ROS increased  
LPO increased  
Lipid peroxides increased  
Antioxidant vitamins decreased  
LPO increased  
ROS increased; antioxidants lower  
LPO increased, vitamins lower  
GPx activity decreased  
MDA increased; GSH lower  
ROS increased  
MDA increased; SOD/CAT/GPx lower  
LPO increased; GSH lowered  
Cornea/lens MDA increased  
Superoxide increased  
No significant MDA change  
No parotid salivary oxidative change  
No significant antioxidant changes  
No oxidative changes in offspring  
Salivary oxidative biomarkers higher

MDA higher, SOD/GPx lower  
 Protein kinase and apoptotic changes  
 No salivary oxidative change  
 Oxidative stress observed  
 ROS changed  
 Free radicals changed with GSM-DTX  
 Carbonyl/oxidative index increased  
 LPO increased, erythrocyte enzymes lower  
 MDA / protein carbonyl increased  
 Brain MDA increased  
 Altered ROS balance, NADPH-associated pathways; enl  
 Higher MDA, 8-OHdG, TOS and DNA damage in RF group  
 Increased hepatic MDA/Nrf2, altered SOD and CAT  
 Elevated MDA and changes in SOD/CAT-related endpoi  
 Altered oxidative markers and morphology  
 Reported oxidative injury and histological effects  
 Altered hemolymph biochemistry and stress-related ;  
 ROS/mitochondrial oxidative stress and apoptosis-r  
 Higher TOS and inflammatory markers; reduced TAS  
 Higher MDA, altered antioxidant enzymes, chromosom  
 Elevated larval TBARS at highest field location; n  
 No significant change in tested antioxidant or oxi  
 No significant change in mitochondrial ROS with co  
 Higher cellular ROS at 60–120 min for mobile phone  
 Superoxide increased time/frequency-dependently; N  
 Mitochondrial depolarization and pharmacologically  
 Assessed cellular redox balance; quantitative dire  
 Measured DCFH-DA ROS, MDA, carbonyls and GSH; dire  
 Changed ROS-related gene expression following 15 m  
 ROS increases in some exposure amplitudes; nonline  
 Higher ROS, NO, MDA and apoptosis-associated marke  
 Antioxidant enzyme activity increased at longer ex  
 No statistically significant change in measured ce  
 No increase in ROS alone or with FeSO4  
 No RF-alone ROS change; some pretreatment conditio  
 RF pretreatment reduced chemically induced oxidati  
 Changed islet oxidative markers and insulin secret  
 Higher oxidative-stress markers; APX/POD increased  
 Increased brain lipid oxidation and reduced antiox  
 Reported oxidative-stress and reproductive inflammm  
 Elevated MDA and reduced SOD after RF, Zn-associat  
 Reduced antioxidant capacity/enzyme activity; no s  
 Higher MDA/TOS and lower TAS/SOD in prenatal group  
 Elevated MDA; reduced antioxidant enzyme activity  
 EMR altered ROS/redox; sulforaphane partly mitigat  
 MDA/peroxidative injury and sperm changes; nonmono

Increased lipid peroxidation in liver, brain and spleen  
 Higher lipid peroxidation, reduced antioxidant markers  
 Lower UV-induced ROS accumulation and DNA damage with  
 Higher ROS and apoptosis pathway markers  
 No significant ROS change or DNA-repair interference  
 ROS decreased in fibroblasts at 1 W/kg; slight UV-induced  
 Measured oxidative status alongside DNA/chromosomal  
 4.2 MHz associated with altered mitochondrial mass  
 Changes in proportions with membrane damage/good  $\Delta$   
 No significant mitochondrial membrane-potential changes  
 Reported mitochondrial DNA genotoxicity in epididymal  
 No significant mitochondrial membrane-potential changes  
 RF exposure alone did not significantly change endogenous  
 Review reports altered germ-cell mitochondrial membrane  
 Increased mitochondrial oxidative damage and ROS; increased  
 Most pronounced mitochondrial dysfunction and cognitive  
 Both 900 and 1800 MHz groups showed mitochondrial dysfunction  
 Brown fat mitochondrial activity decreased after 3 weeks  
 Increased mitochondrial ROS after one week; sperm motility  
 Complexes I–IV increased; mitochondrial respiration  
 Reduced amyloid-beta/H<sub>2</sub>O<sub>2</sub>-induced mitochondrial ROS  
 Impaired respiration only under glucose deprivation  
 No significant RF-versus-sham mitochondrial potential  
 Dose-related mitochondrial ROS and oxidative DNA damage  
 Increased mitochondrial oxidative DNA damage; reduced  
 Increased mitochondria-targeted ROS signal and cytochrome  
 Mitochondrial ROS increased in germ cells; complex  
 Increased swollen, vesicular mitochondria after 48 h  
 No significant mitochondrial ROS change under GSM/  
 RF exposures altered  $\Delta\Psi_m$  and ATP; Mito-TEMPO attenuated  
 Increased ROS and lower membrane potential; redox imbalance  
 Altered respiration and increased swelling; effects on  
 Mitochondrial activity changed depending on RF plus  
 Mixed, cell- and UV-challenge-dependent responses;  
 No significant baseline or chemically challenged mitochondrial  
 Smaller mitochondria and chloroplasts; altered plasma  
 More expanded mitochondria and endoplasmic reticulum  
 Greater OXPHOS transcription and ATP in mutant cytochrome  
 PEMF shifted metabolism toward glycolysis and altered  
 Increased mtDNA synthesis in specific renal tubules  
 No detectable  $\Delta\Psi_m$  change despite reported nuclear  
 Lower mitochondrial activity and sperm motility with  
 Mitochondrial dilation in stromal cells (review)  
 Increase in mitochondrial potential and cellular energy  
 Increased mitochondrial activity and oxidative-protection  
 Altered mitochondrial metabolism/proliferation; protective

Transient mPTP opening/cytochrome c release;  $\Delta\Psi_m$  ↑  
Enhanced mitochondrial metabolism and cell proliferation  
mtROS release associated with resistance to induction of apoptosis  
No statistically significant mitochondrial  $\Delta\Psi_m$  changes  
Time- and cell-type-dependent mitochondrial potential  
mPTP-associated response and DNA damage in senescent cells  
PEMF promoted glycolytic energy use and migration  
Increased mitochondrial antioxidant MnSOD, reduction of nitrotyrosine  
29% higher thymocyte mitochondrial fluorescence in senescent cells  
Altered morphology and potential; impaired respiration  
Oxidative/apoptotic responses; mitochondrial mechanical properties  
ATP decreased at 200 and 591 MHz, not at 2450 MHz;  
Reduced ATP and phosphocreatine at 591 MHz; mitochondrial  
ROS increased and motility impaired; mitochondrial membrane  
Study emphasizes beta-amyloid and cognition, and role of  
RF plus Ru360 caused higher DNA damage/apoptosis than  
Time- and frequency-dependent redox/apoptosis changes  
RF pre-exposure mitigated some menadione oxidative damage  
Altered mitochondrial colocalization of peptides; increased  
ROS and altered germ-cell cycle described; mitochondrial  
28 GHz coexposure aggravated doxorubicin-related cellular damage  
Sublethal cell injury and changes to cellular ultrastructure  
PEMF attenuated H<sub>2</sub>O<sub>2</sub>-associated oxidative changes  
Mobile-phone use associated with increased seminal ROS

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Direct mitochondrial endpointFrequencies 3–5 MHz; sorting at representative 4.2

Direct mitochondrial endpointThree tested carrier frequencies in ONE study; DNA

Direct mitochondrial endpoint

Direct mitochondrial endpoint

Direct mitochondrial endpoint

Direct mitochondrial endpointCombination experiment; protective effect cannot be

Direct mitochondrial endpointMitochondrial endpoint verified in Santini 2018 se

Direct mitochondrial endpoint

Direct mitochondrial endpointStudy compared 900, 1800 and 2450 MHz: effect high

Direct mitochondrial endpointTwo frequency groups within one publication.

Direct mitochondrial endpoint

Direct mitochondrial endpointSperm DNA oxidation is not necessarily mtDNA damage

Direct mitochondrial endpoint

Direct mitochondrial endpointUnder chemical stress; protective response not gen

Direct mitochondrial endpoint

Direct mitochondrial endpoint

Direct mitochondrial endpoint2013 publisher correction; original and correction

Direct mitochondrial endpoint

Direct mitochondrial endpoint

Direct mitochondrial endpoint

Direct mitochondrial endpoint

Direct mitochondrial endpointMixed-frequency coexposure: 1800 and 3500 MHz; not

Direct mitochondrial endpointPublished October 15, 2026; very recent, no indepe

Direct mitochondrial endpoint

Direct mitochondrial endpointIsolated mitochondria; relatively intense exposure,

Direct mitochondrial endpointEffects largely conditional on LPS/spike challenge

Direct mitochondrial endpoint

Direct mitochondrial endpoint

Direct mitochondrial endpointPlant mitochondria ultrastructure; exact frequenci

Direct mitochondrial endpointDirect organelle morphology; frequency unknown in

Direct mitochondrial endpointStudy uses induced/therapeutic mitochondrial respo

Direct mitochondrial endpointTherapeutic-oriented PEMF; do not generalize to am

Direct mitochondrial endpoint

Direct mitochondrial endpointAn EDITORIAL EXPRESSION OF CONCERN exists (PMID 20

Direct mitochondrial endpoint

Direct mitochondrial endpointPrimary paper not linked directly; citation in San

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Direct mitochondrial endpoint  
Direct mitochondrial endpointTherapeutic-oriented PEMF.  
Direct mitochondrial endpointField frequency not confirmed from checked citation  
Direct mitochondrial endpointBroadband therapeutic apparatus, low-frequency source  
Direct mitochondrial endpointHigh-power noninvasive cancer treatment, NOT compared  
Indirect mitochondrial mechanismDo not infer mtDNA effects from p53/p21 activation  
Indirect mitochondrial mechanismThree frequencies within one publication; source a  
Indirect mitochondrial mechanismDirect mitochondrial function was not measured.  
Indirect mitochondrial mechanismRetain only as sperm ROS mechanistic context; not a  
Indirect mitochondrial mechanismMitochondrial change not validated as an endpoint  
Indirect mitochondrial mechanismPerturbation of mitochondrial  $\text{Ca}^{2+}$  uptake may modulate  
Indirect mitochondrial mechanismSeparate paper from October 15 2026 mitochondria-s  
Mitochondrial relevance neededContext study; not verified direct mitochondrial-s  
Mitochondrial relevance neededDelivery/localization study; mitochondrial bioenergetics  
Indirect mitochondrial mechanismPrimary bibliographic ID not independently verified  
Indirect mitochondrial mechanismChemotherapy interaction, not demonstrated RF-induced  
Mitochondrial relevance neededDo not equate general TEM ultrastructure with a specific  
Mitochondrial relevance neededRequires full-text check for mitochondrion-specific  
Human observational proxy Frequency 900 MHz placeholder was NOT measured; mechanism

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Reference

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## Theme / recommendation

Human symptom prevalence

Clinical documentation/accommod

Exposure measurement

Historical baseline

Device power controls

Cell tower main beam

Cancer and promotion

Redox/ROS

Mitochondrial/mtDNA

Methylation

VGCC

BBB

Ecological effects

Insurance

Research funding

## Prior evidence status

Historical self-report surveys; current US uncertain

Policy guidance and specific coding sources

Standards and measured spatial heterogeneity

Historical natural/engineered exposure data incomplete

Existing engineering technology, not RF health intervention trial

Direct engineering studies

Animal positive, human epidemiology null/mixed

143-record register; published systematic review very low certainty

63-record register; RF+ELF+therapeutic mixed

RF cultured-cell report; clinical MTHFR pathway evidence unestablished

Mechanistic review hypothesis; limited clinical validation

2026 scoping review 17 positive / 18 null

Bee studies, different endpoints

Corporate exclusion documented; patient denial rate unknown

Most previous rows unaudited; known utility funding in California surv

## Study examples in submission

[2-4, 45-46]

[6-10]

[11-13, 19-22, 62-63, 69]

[14-15]

[16]

[19-22, 62-63, 69]

[47-55, 61, 67]

[29-30, 66]

[38-44, 64]

[56]

[57]

[58]

[59-60]

[36-37]

[2, 26, 34, 56]

## Next verification action

Nationwide weighted survey and validated measures  
EHS attribution field not a diagnosis; insurance access audit  
Require harmonized frequency-resolved dosimetry  
Reconstruction; no invented numerical health baseline  
Field pilot with reliability, coverage, total energy metrics  
Develop national exposure protocol; HHS determines siting rules  
Independent mouse co-promoter replication and CBTRUS specific trends  
Independent bias assessment, verified primary paper links  
Separate RF, identify germline direct studies, sequence mtDNA  
Replicate single experiment; pre-specify one-carbon markers  
Live-cell calcium assays with controlled interventions  
Thermal/sham/dosimetry replication  
Independent controlled ecosystem field studies  
Regulatory inventory, health benefit claims and appeal data  
Full acknowledgments/COIs institutional/indirect analysis