HHS RF/EMF — EVIDENCE REVIEW REGISTE

Status

Recovered rows

Interpretation

RF vs ELF

Funding disclosure

Primary links

Evidence directions

Corrigenda

Links: 'Click to open source' uses s1

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 verifi
Mitochondrial register includes 30 direct RF, 18 ELF/PEMF and 15 indirect/special entries; dc
Funding provenance for most individual studies is NOT independently audited. Do not label inc
Some Yakymenko links are PubMed search queries rather than direct article records.
Preserve null, positive, mixed and beneficial findings. Selected studies include systematic r
Animal cancer Mevissen 2025 has 2026 corrigendum; pregnancy Cordelli 2023 has 2025 corrigendu
The concise and full research submissions refer to this register for supporting sources and v

ication rem
o not pool.
dependent.

reviews.
um.
verificatic

ID	Source inventory	Exposure category
YAK-001	Yakymenko original 100	RF (as listed in review)
YAK-002	Yakymenko original 100	RF (as listed in review)
YAK-003	Yakymenko original 100	RF (as listed in review)
YAK-004	Yakymenko original 100	RF (as listed in review)
YAK-005	Yakymenko original 100	RF (as listed in review)
YAK-006	Yakymenko original 100	RF (as listed in review)
YAK-007	Yakymenko original 100	RF (as listed in review)
YAK-008	Yakymenko original 100	RF (as listed in review)
YAK-009	Yakymenko original 100	RF (as listed in review)
YAK-010	Yakymenko original 100	RF (as listed in review)
YAK-011	Yakymenko original 100	RF (as listed in review)
YAK-012	Yakymenko original 100	RF (as listed in review)
YAK-013	Yakymenko original 100	RF (as listed in review)
YAK-014	Yakymenko original 100	RF (as listed in review)
YAK-015	Yakymenko original 100	RF (as listed in review)
YAK-016	Yakymenko original 100	RF (as listed in review)
YAK-017	Yakymenko original 100	RF (as listed in review)
YAK-018	Yakymenko original 100	RF (as listed in review)
YAK-019	Yakymenko original 100	RF (as listed in review)
YAK-020	Yakymenko original 100	RF (as listed in review)
YAK-021	Yakymenko original 100	RF (as listed in review)
YAK-022	Yakymenko original 100	RF (as listed in review)
YAK-023	Yakymenko original 100	RF (as listed in review)
YAK-024	Yakymenko original 100	RF (as listed in review)
YAK-025	Yakymenko original 100	RF (as listed in review)
YAK-026	Yakymenko original 100	RF (as listed in review)
YAK-027	Yakymenko original 100	RF (as listed in review)
YAK-028	Yakymenko original 100	RF (as listed in review)
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YAK-030	Yakymenko original 100	RF (as listed in review)
YAK-031	Yakymenko original 100	RF (as listed in review)
YAK-032	Yakymenko original 100	RF (as listed in review)
YAK-033	Yakymenko original 100	RF (as listed in review)
YAK-034	Yakymenko original 100	RF (as listed in review)
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YAK-037	Yakymenko original 100	RF (as listed in review)
YAK-038	Yakymenko original 100	RF (as listed in review)
YAK-039	Yakymenko original 100	RF (as listed in review)
YAK-040	Yakymenko original 100	RF (as listed in review)
YAK-041	Yakymenko original 100	RF (as listed in review)
YAK-042	Yakymenko original 100	RF (as listed in review)
YAK-043	Yakymenko original 100	RF (as listed in review)
YAK-044	Yakymenko original 100	RF (as listed in review)

YAK-045	Yakymenko original	100	RF (as listed in review)
YAK-046	Yakymenko original	100	RF (as listed in review)
YAK-047	Yakymenko original	100	RF (as listed in review)
YAK-048	Yakymenko original	100	RF (as listed in review)
YAK-049	Yakymenko original	100	RF (as listed in review)
YAK-050	Yakymenko original	100	RF (as listed in review)
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YAK-081	Yakymenko original	100	RF (as listed in review)
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YAK-093	Yakymenko original 100	RF (as listed in review)
YAK-094	Yakymenko original 100	RF (as listed in review)
YAK-095	Yakymenko original 100	RF (as listed in review)
YAK-096	Yakymenko original 100	RF (as listed in review)
YAK-097	Yakymenko original 100	RF (as listed in review)
YAK-098	Yakymenko original 100	RF (as listed in review)
YAK-099	Yakymenko original 100	RF (as listed in review)
YAK-100	Yakymenko original 100	RF (as listed in review)
NEW-001	Supplementary redox 43	RF (as classified in registeı
NEW-002	Supplementary redox 43	RF (as classified in registeı
NEW-003	Supplementary redox 43	RF (as classified in registeı
NEW-004	Supplementary redox 43	RF (as classified in registeı
NEW-005	Supplementary redox 43	RF (as classified in registeı
NEW-006	Supplementary redox 43	RF (as classified in registeı
NEW-007	Supplementary redox 43	RF (as classified in registeı
NEW-008	Supplementary redox 43	RF (as classified in registeı
NEW-009	Supplementary redox 43	RF (as classified in registeı
NEW-010	Supplementary redox 43	RF (as classified in registeı
NEW-011	Supplementary redox 43	RF (as classified in registeı
NEW-012	Supplementary redox 43	RF (as classified in registeı
NEW-013	Supplementary redox 43	RF (as classified in registeı
NEW-014	Supplementary redox 43	RF (as classified in registeı
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NEW-016	Supplementary redox 43	RF (as classified in registeı
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NEW-018	Supplementary redox 43	RF (as classified in registeı
NEW-019	Supplementary redox 43	RF (as classified in registeı
NEW-020	Supplementary redox 43	RF (as classified in registeı
NEW-021	Supplementary redox 43	RF (as classified in registeı
NEW-022	Supplementary redox 43	RF (as classified in registeı
NEW-023	Supplementary redox 43	RF (as classified in registeı
NEW-024	Supplementary redox 43	RF (as classified in registeı
NEW-025	Supplementary redox 43	RF (as classified in registeı
NEW-026	Supplementary redox 43	RF (as classified in registeı
NEW-027	Supplementary redox 43	RF (as classified in registeı
NEW-028	Supplementary redox 43	RF (as classified in registeı
NEW-029	Supplementary redox 43	RF (as classified in registeı
NEW-030	Supplementary redox 43	RF (as classified in registeı
NEW-031	Supplementary redox 43	RF (as classified in registeı
NEW-032	Supplementary redox 43	RF (as classified in registeı
NEW-033	Supplementary redox 43	RF (as classified in registeı
NEW-034	Supplementary redox 43	RF (as classified in registeı
NEW-035	Supplementary redox 43	RF (as classified in registeı
NEW-036	Supplementary redox 43	RF (as classified in registeı

NEW-037	Supplementary redox 43	RF (as classified in registe
NEW-038	Supplementary redox 43	RF (as classified in registe
NEW-039	Supplementary redox 43	RF (as classified in registe
NEW-040	Supplementary redox 43	RF (as classified in registe
NEW-041	Supplementary redox 43	RF (as classified in registe
NEW-042	Supplementary redox 43	RF (as classified in registe
NEW-043	Supplementary redox 43	RF (as classified in registe
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 fibrobla	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-rc	900, 1800
Prenatal/postnatal study	Rats, offspring brain and kidne	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 cel	1950
Sannino et al. (2023)	Hamster lung V79 cells	1950
Sannino et al. (2024)	Human neuroblastoma SH-SY5Y cel	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 (2…	Human 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 stati…	Human 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 l	918 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 s	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
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 u	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 parame	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	Indirect oxidative biomarker / re
Phone source; specific wavef	Null oxidative marker finding
Phone source; specific wavef	Indirect oxidative biomarker / re
CW and modulated / pulsed (b	Direct ROS / ROS-associated radic
CW and modulated / pulsed (b	Indirect oxidative biomarker / re
Phone source; specific wavef	Indirect oxidative biomarker / re
Phone source; specific wavef	Indirect oxidative biomarker / re
Phone source; specific wavef	Indirect oxidative biomarker / re
Phone source; specific wavef	Indirect oxidative biomarker / re
Research RF; modulation not	Direct ROS/redox
Lab RF generator; waveform n	Indirect oxidation/DNA damage
GSM antenna emissions; modul	Indirect oxidative markers
GSM 900 MHz; modulated sourc	Indirect 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 ex	Direct/indirect ROS oxidative mar
RF exposure; waveform not ve	Indirect oxidant/antioxidant stat
RF source; modulation not ve	Indirect lipid oxidation/enzymes
Base-station field; environm	Indirect lipid oxidation/enzymes
Experimental 915 MHz RF; wav	Null antioxidant/proxy assessment
GSM- and 5G-modulated, expli	Direct ROS, null
4G mobile + 1800/2450 genera	Direct ROS
4G handset + 1800/2450 gener	Direct superoxide/NO
4G handset + 1800/2450 gener	Direct ROS with mitochondrial mar
Laboratory RF source; wavefo	ROS/oxidation investigation
GTEM 1800 MHz; waveform not	Direct ROS and indirect oxidation
Single-frequency RF carrier;	Gene expression / ROS inference
Single carrier; no communica	Direct ROS
Mobile-phone dialing/receivi	Direct ROS plus indirect
RF exposure; modulation not	Indirect redox/enzymes
GSM-like pulse modulation, 2	Direct ROS, null
UMTS 1950 MHz; modulated	Direct ROS, null
Both LTE-modulated and unmod	Direct 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 v	Indirect oxidative biomarkers
2.45 GHz experimental RF; mo	Indirect lipid oxidation/enzymes
Wi-Fi traffic; continuous du	Indirect antioxidants; mixed endp
Wireless device-like exposur	Indirect lipid oxidation/enzymes
High-intensity microwave; wa	Indirect lipid oxidation/enzymes
2.45 GHz experimental RF; mo	Direct 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 n	Mitochondrial respiration, mass;
Continuous RF at individual 7	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 char	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 modu	Mitochondrial membrane potential
Waveguide signal; modulation	Mitochondrial ROS; mitochondrial
217 Hz pulse-modulated	Mitochondrial 8-OHdG; mtDNA copy
Continuous 1800 MHz irradiat	MitoSOX mitochondrial ROS; cytoch
Continuous wave (CW)	Mitochondrial ROS; ETC complex II
Intermittent RF exposure (no	Mitochondrial electron microscopy
GSM-modulated and 5G-modulate	MitoSOX mitochondrial ROS
4G phone and RF signal gener	Membrane potential (JC-1), ATP, R
Antenna radiation; waveform r	ΔΨm, NAD+/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 fi	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 con	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, 2	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 in	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+-depe

Reported finding
Nitric oxide increased
H2O2/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/NOx 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
H2O2 and MDA increased
Thymic LPO/protein oxidation increased
Protein carbonyl/MDA increased
TBARS increased
MDA/enzymes altered

Kidney/testis LPO increased
ROS increased with FeCl2
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/NOx 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 inflamm
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 s
Higher lipid peroxidation, reduced antioxidant mar
Lower UV-induced ROS accumulation and DNA damage u
Higher ROS and apoptosis pathway markers
No significant ROS change or DNA-repair interferen
ROS decreased in fibroblasts at 1 W/kg; slight UV-
Measured oxidative status alongside DNA/chromosoma
4.2 MHz associated with altered mitochondrial mass
Changes in proportions with membrane damage/good Δ
No significant mitochondrial membrane-potential ch
Reported mitochondrial DNA genotoxicity in epididy
No significant mitochondrial membrane-potential ch
RF exposure alone did not significantly change end
Review reports altered germ-cell mitochondrial mem
Increased mitochondrial oxidative damage and ROS;
Most pronounced mitochondrial dysfunction and cogn
Both 900 and 1800 MHz groups showed mitochondrial
Brown fat mitochondrial activity decreased after 3
Increased mitochondrial ROS after one week; sperm
Complexes I–IV increased; mitochondrial respiratio
Reduced amyloid-beta/H2O2-induced mitochondrial RO
Impaired respiration only under glucose deprivatio
No significant RF-versus-sham mitochondrial potent
Dose-related mitochondrial ROS and oxidative DNA d
Increased mitochondrial oxidative DNA damage; redu
Increased mitochondria-targeted ROS signal and cyt
Mitochondrial ROS increased in germ cells; complex
Increased swollen, vesicular mitochondria after 48
No significant mitochondrial ROS change under GSM/
RF exposures altered ΔΨm and ATP; Mito-TEMPO atter
Increased ROS and lower membrane potential; redox
Altered respiration and increased swelling; effect
Mitochondrial activity changed depending on RF plu
Mixed, cell- and UV-challenge-dependent responses;
No significant baseline or chemically challenged m
Smaller mitochondria and chloroplasts; altered pla
More expanded mitochondria and endoplasmic reticul
Greater OXPHOS transcription and ATP in mutant cyb
PEMF shifted metabolism toward glycolysis and alte
Increased mtDNA synthesis in specific renal tubula
No detectable ΔΨm change despite reported nuclear
Lower mitochondrial activity and sperm motility wi
Mitochondrial dilation in stromal cells (review)
Increase in mitochondrial potential and cellular e
Increased mitochondrial activity and oxidative-pro
Altered mitochondrial metabolism/proliferation; pa

Transient mPTP opening/cytochrome c release; ΔΨm u
Enhanced mitochondrial metabolism and cell prolife
mtROS release associated with resistance to induce
No statistically significant mitochondrial ΔΨm cha
Time- and cell-type-dependent mitochondrial potent
mPTP-associated response and DNA damage in senesce
PEMF promoted glycolytic energy use and migration
Increased mitochondrial antioxidant MnSOD, reducti
29% higher thymocyte mitochondrial fluorescence in
Altered morphology and potential; impaired respira
Oxidative/apoptotic responses; mitochondrial mecha
ATP decreased at 200 and 591 MHz, not at 2450 MHz;
Reduced ATP and phosphocreatine at 591 MHz; mitoch
ROS increased and motility impaired; mitochondrial
Study emphasizes beta-amyloid and cognition, and r
RF plus Ru360 caused higher DNA damage/apoptosis t
Time- and frequency-dependent redox/apoptosis chan
RF pre-exposure mitigated some menadione oxidative
Altered mitochondrial colocalization of peptides;
ROS and altered germ-cell cycle described; mitocho
28 GHz coexposure aggravated doxorubicin-related c
Sublethal cell injury and changes to cellular ultra
PEMF attenuated H2O2-associated oxidative changes
Mobile-phone use associated with increased seminal

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https://pubmed.ncbi.nlm.nih.gov/?term=Dasdag%202008%20radiofrequen
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https://pubmed.ncbi.nlm.nih.gov/?term=Esmekaya%202011%20radiofrequ
https://pubmed.ncbi.nlm.nih.gov/?term=Guney%202007%20radiofrequenc
https://pubmed.ncbi.nlm.nih.gov/?term=Ilhan%202004%20radiofrequenc
https://pubmed.ncbi.nlm.nih.gov/?term=Jelodar%202013%20radiofreque
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https://pubmed.ncbi.nlm.nih.gov/?term=Kerman%20%26%20Senol%202012%2
https://pubmed.ncbi.nlm.nih.gov/?term=Kesari%202011%20radiofrequen
https://pubmed.ncbi.nlm.nih.gov/?term=Koylu%202006%20radiofrequenc
https://pubmed.ncbi.nlm.nih.gov/?term=Koyu%202009%20radiofrequency
https://pubmed.ncbi.nlm.nih.gov/?term=Lu%202012%20radiofrequency%20
https://pubmed.ncbi.nlm.nih.gov/?term=Luo%202014%20radiofrequency%2
https://pubmed.ncbi.nlm.nih.gov/?term=Mailankot%202009%20radiofrequ
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https://pubmed.ncbi.nlm.nih.gov/?term=Megha%202012%20radiofrequenc
https://pubmed.ncbi.nlm.nih.gov/?term=Oktem%202005%20radiofrequenc
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https://pubmed.ncbi.nlm.nih.gov/?term=Ragy%202014%20radiofrequency
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https://pubmed.ncbi.nlm.nih.gov/?term=Furtado-Filho%202014%20radio
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https://pubmed.ncbi.nlm.nih.gov/?term=Avci%202012%20radiofrequency
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https://pubmed.ncbi.nlm.nih.gov/?term=Garaj-Vrhovac%202011%20radio
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https://pubmed.ncbi.nlm.nih.gov/?term=Motawi%202014%20radiofrequen
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https://pubmed.ncbi.nlm.nih.gov/?term=Sokolovic%202008%20radiofrequ
https://pubmed.ncbi.nlm.nih.gov/?term=Suleyman%202004%20radiofrequ
https://doi.org/10.3389/fpubh.2024.1425023
https://pubmed.ncbi.nlm.nih.gov/30669883/
https://pubmed.ncbi.nlm.nih.gov/31304806/
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https://pubmed.ncbi.nlm.nih.gov/42880645/
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https://pmc.ncbi.nlm.nih.gov/articles/PMC11939444/
https://doi.org/10.1080/19420889.2022.2027698
https://pubmed.ncbi.nlm.nih.gov/29637556/
https://pubmed.ncbi.nlm.nih.gov/39472374/
https://doi.org/10.1371/journal.pone.0054906
https://pubmed.ncbi.nlm.nih.gov/19475646/
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https://pubmed.ncbi.nlm.nih.gov/39315584/
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https://pubmed.ncbi.nlm.nih.gov/18163440/
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https://pubmed.ncbi.nlm.nih.gov/28340409/
https://pubmed.ncbi.nlm.nih.gov/29872015/
https://pubmed.ncbi.nlm.nih.gov/29332300/
https://pubmed.ncbi.nlm.nih.gov/37445806/
https://pubmed.ncbi.nlm.nih.gov/31767903/
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https://pubmed.ncbi.nlm.nih.gov/30953670/
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https://pubmed.ncbi.nlm.nih.gov/19649291/
https://pubmed.ncbi.nlm.nih.gov/19879861/
https://pubmed.ncbi.nlm.nih.gov/27689798/
https://pubmed.ncbi.nlm.nih.gov/30298125/
https://pubmed.ncbi.nlm.nih.gov/32013005/
https://pubmed.ncbi.nlm.nih.gov/41104878/
https://pubmed.ncbi.nlm.nih.gov/42880645/
https://pubmed.ncbi.nlm.nih.gov/38137349/
https://pubmed.ncbi.nlm.nih.gov/38843455/
https://pubmed.ncbi.nlm.nih.gov/42123398/
https://pubmed.ncbi.nlm.nih.gov/38115173/
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https://pubmed.ncbi.nlm.nih.gov/25050479/
https://pubmed.ncbi.nlm.nih.gov/24202060/
https://pubmed.ncbi.nlm.nih.gov/40629055/
https://pubmed.ncbi.nlm.nih.gov/39152229/
https://pubmed.ncbi.nlm.nih.gov/14689206/
https://pubmed.ncbi.nlm.nih.gov/15340854/
https://pubmed.ncbi.nlm.nih.gov/17196643/
https://onlinelibrary.wiley.com/doi/full/10.1155/2018/5076271
https://pubmed.ncbi.nlm.nih.gov/20690107/
https://pubmed.ncbi.nlm.nih.gov/24374227/
https://pubmed.ncbi.nlm.nih.gov/26762464/

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https://pubmed.ncbi.nlm.nih.gov/26757151/
https://pubmed.ncbi.nlm.nih.gov/27310130/
https://pubmed.ncbi.nlm.nih.gov/33052723/
https://pubmed.ncbi.nlm.nih.gov/36378418/
https://pubmed.ncbi.nlm.nih.gov/39642656/
https://pubmed.ncbi.nlm.nih.gov/39939866/
https://pubmed.ncbi.nlm.nih.gov/25708841/
https://pubmed.ncbi.nlm.nih.gov/42078208/
https://pubmed.ncbi.nlm.nih.gov/24986120/
https://pubmed.ncbi.nlm.nih.gov/28323003/
https://pubmed.ncbi.nlm.nih.gov/6517961/
https://pubmed.ncbi.nlm.nih.gov/7284022/
https://pubmed.ncbi.nlm.nih.gov/18804757/
https://pubmed.ncbi.nlm.nih.gov/22558216/
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https://pubmed.ncbi.nlm.nih.gov/42277135/
https://onlinelibrary.wiley.com/doi/full/10.1155/2018/5076271
https://pubmed.ncbi.nlm.nih.gov/41478317/
https://pubmed.ncbi.nlm.nih.gov/15868940/
https://pubmed.ncbi.nlm.nih.gov/26940444/
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Reported status / type	Evidence/verification warning
Positive	Review-derived; primary metadata not all verified
Positive	Review-derived; primary metadata not all verified
Null	Review-derived; primary metadata not all verified
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Positive		Review-derived; primary metadata not all verified
As reported: Direct ROS		Source is specific article page/DOI; not all full
As reported: Indirect / pro:		Source is specific article page/DOI; not all full
As reported: Indirect / pro:		Source is specific article page/DOI; not all full
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As reported: Direct ROS	Source is specific article page/DOI; not all full	
As reported: Indirect / pro	Source is specific article page/DOI; not all full	
Direct mitochondrial endpoi	Frequencies 3–5 MHz; sorting at representative 4.2	
Direct mitochondrial endpoi	Three tested carrier frequencies in ONE study; DNA	
Direct mitochondrial endpoint		
Direct mitochondrial endpoint		
Direct mitochondrial endpoint		
Direct mitochondrial endpoi	Combination experiment; protective effect cannot b	
Direct mitochondrial endpoi	Mitochondrial endpoint verified in Santini 2018 se	
Direct mitochondrial endpoint		
Direct mitochondrial endpoi	Study compared 900, 1800 and 2450 MHz: effect high	
Direct mitochondrial endpoi	Two frequency groups within one publication.	
Direct mitochondrial endpoint		
Direct mitochondrial endpoi	Sperm DNA oxidation is not necessarily mtDNA damag	
Direct mitochondrial endpoint		
Direct mitochondrial endpoi	Under chemical stress; protective response not gen	
Direct mitochondrial endpoint		
Direct mitochondrial endpoint		
Direct mitochondrial endpoi	2013 publisher correction; original and correction	
Direct mitochondrial endpoint		
Direct mitochondrial endpoint		
Direct mitochondrial endpoint		
Direct mitochondrial endpoint		
Direct mitochondrial endpoi	Mixed-frequency coexposure: 1800 and 3500 MHz; not	
Direct mitochondrial endpoi	Published October 15, 2026; very recent, no indepe	
Direct mitochondrial endpoint		
Direct mitochondrial endpoi	Isolated mitochondria; relatively intense exposure,	
Direct mitochondrial endpoi	Effects largely conditional on LPS/spike challenge	
Direct mitochondrial endpoint		
Direct mitochondrial endpoint		
Direct mitochondrial endpoi	Plant mitochondria ultrastructure; exact frequenci	
Direct mitochondrial endpoi	Direct organelle morphology; frequency unknown in	
Direct mitochondrial endpoi	Study uses induced/therapeutic mitochondrial respo	
Direct mitochondrial endpoi	Therapeutic-oriented PEMF; do not generalize to am	
Direct mitochondrial endpoint		
Direct mitochondrial endpoi	An EDITORIAL EXPRESSION OF CONCERN exists (PMID 20	
Direct mitochondrial endpoint		
Direct mitochondrial endpoi	Primary paper not linked directly; citation in San	
Direct mitochondrial endpoint		
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Direct mitochondrial endpoint	
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Direct mitochondrial endpoi	Therapeutic-oriented PEMF.
Direct mitochondrial endpoi	Field frequency not confirmed from checked citatio
Direct mitochondrial endpoi	Broadband therapeutic apparatus, low-frequency sou
Direct mitochondrial endpoi	High-power noninvasive cancer treatment, NOT compa
Indirect mitochondrial mech	Do not infer mtDNA effects from p53/p21 activation
Indirect mitochondrial mech	Three frequencies within one publication; source a
Indirect mitochondrial mech	Direct mitochondrial function was not measured.
Indirect mitochondrial mech	Retain only as sperm ROS mechanistic context; not
Indirect mitochondrial mech	Mitochondrial change not validated as an endpoint
Indirect mitochondrial mech	Perturbation of mitochondrial Ca^{2+} uptake may modul
Indirect mitochondrial mech	Separate paper from October 15 2026 mitochondria-s
Mitochondrial relevance nee	Context study; not verified direct mitochondrial-s
Mitochondrial relevance nee	Delivery/localization study; mitochondrial bioener
Indirect mitochondrial mech	Primary bibliographic ID not independently verifie
Indirect mitochondrial mech	Chemotherapy interaction, not demonstrated RF-indu
Mitochondrial relevance nee	Do not equate general TEM ultrastructure with a sp
Mitochondrial relevance nee	Requires full-text check for mitochondrion-specifi
Human observational proxy	Frequency 900 MHz placeholder was NOT measured; ma

Risk-of-bias status	Funding provenance
Not independently rated; sham/blindir	Funding not audited
Not independently rated; sham/blindir	Funding not audited
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URL status	Click to open source
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Reference

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54
55
56
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58
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60
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64
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67
68
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Source / research description
Lloyd's emerging risks team. Electromagnetic fields from mobile phones: recent developments (
Hammond Power Solutions v. National Union Fire Insurance Co. (7th Cir., July 9, 2025). Court
Xu et al. (2010). Exposure to 1800 MHz radiofrequency radiation induces oxidative damage to n
Rebolledo-Jaramillo et al. (2014). Maternal age effect and severe germ-line bottleneck in the
Zaidi et al. (2019). Bottleneck and selection in the germline and maternal age influence tran
Aitken et al. (2005). Impact of radio frequency electromagnetic radiation on DNA integrity in
Whole-body exposures to radiofrequency-electromagnetic energy can cause DNA damage in mouse s
Cordelli et al. (2023). Pregnancy and birth outcomes in RF-exposed experimental animals: syst
Cordelli et al. (2024). Male fertility effects in nonhuman mammals and human sperm in vitro:
Systematic review (2024). RF-EMF exposure and self-reported symptoms in human experiments; mo
Röösli et al. (2024). Tinnitus, migraine and nonspecific symptoms in human observational stud
Tillmann et al. (2010). Indication of cocarcinogenic potential of chronic UMTS-modulated RF e
Lerchl et al. (2015). Tumor promotion by RF exposure below limits for humans in a carcinogen-
A systematic review on in vivo RF exposure and co-carcinogenesis (2024); mostly nonsignificar
U.S. National Toxicology Program (2018). NTP Technical Report 595: 900 MHz GSM/CDMA rat study
Falcioni et al. (2018). Ramazzini Institute lifelong 1.8 GHz GSM field study; male-rat heart
Mevissen et al. (2025). RF exposure and cancer in laboratory animals: systematic review; see
Mevissen et al. (2026). Corrigendum to 2025 animal carcinogenicity systematic review; correct
Karipidis et al. (2024). Human RF exposure and common cancer outcomes: systematic review; mod
COSMOS prospective cohort (2024). Mobile-phone use and brain tumor risk among 264,574 partici
Cantu et al. (2023). Whole-genome methylation and transcription changes in human keratinocyte
Pall (2013). VGCC hypothesis synthesis of EMF studies (review; not a demonstration that this
Taspinar Simsek et al. (2026). BBB RF literature scoping review: 17 studies reporting effects
RF exposure and honeybee stress-response enzymes and genes (2023). Controlled bee study; no c
Electromagnetic fields disrupt the pollination service by honeybees (2023). Field/lab study;
CBTRUS statistical report: primary brain and other CNS tumors, diagnoses 2018–2022 (2025). Hi
Determination of the general public exposure around GSM and UMTS base stations (2007). Main-l
Viel et al. (2009). Residential RF personal-meter survey; distance is not a universal proxy;
In-vitro human sperm study (2008). Pulsed 900 MHz GSM exposure did not change mitochondrial m
The effects of RF exposure on human experimental cognitive performance (2024). Systematic rev
NIH/WHO systematic review (2024). RF-EMF oxidative-stress biomarkers, overall very-low-certai
Effects of RF exposure on cancer risk in human populations, Part II (2025); less researched c
Reproductive and pregnancy review corrigendum (2025). Relevant to interpretation of Cordelli
Site-specific RF-EMF exposure classification for epidemiology (2007): 1,100 indoor measuremen
CI evidence source: NIST/ICNIRP/ITU RF exposure standards and measurement frameworks (existin

Direct source URL
https://www.lloyds.com/insights/risk-reports/emf
https://law.justia.com/cases/federal/appellate-courts/ca7/24-1642/24-1642-2025-0
https://pubmed.ncbi.nlm.nih.gov/19879861/
https://pubmed.ncbi.nlm.nih.gov/25313049/
https://pubmed.ncbi.nlm.nih.gov/31757848/
https://pubmed.ncbi.nlm.nih.gov/15910543/
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https://pubmed.ncbi.nlm.nih.gov/20545575/
https://pubmed.ncbi.nlm.nih.gov/25749340/
https://pubmed.ncbi.nlm.nih.gov/39200630/
https://ntp.niehs.nih.gov/publications/reports/tr/tr595
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https://pubmed.ncbi.nlm.nih.gov/40339346/
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https://pubmed.ncbi.nlm.nih.gov/18163440/
https://pubmed.ncbi.nlm.nih.gov/39265322/
https://doi.org/10.1016/j.envint.2024.108940
https://pubmed.ncbi.nlm.nih.gov/39904670/
https://pubmed.ncbi.nlm.nih.gov/39827076/
https://pubmed.ncbi.nlm.nih.gov/17878148/
https://www.itu.int/epublications/publication/itu-t-k-91-2024-01-guidance-for-as

Audit note / scope
Source identified/linked; funding and complete full-text validity not all inde
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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]

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[38–44, 64]

[56]

[57]

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[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 tren
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