

Prepared

Selected source records

Evidence scope

Primary verification

Full-text check

Funding status

Record overlap

Correction alert

Existing register
Links: Each study's URL
remains visible; 'Click to
open source' uses an Excel

EVIDENCE DOSSIER

October 21, 2026

36

Selected affirmative findings that motivate further research; not a systematic review.

Paper identity and reported abstract findings verified through PubMed/publisher links.

Methods were not audited in full for every paper.

Study-level direct/indirect telecom funding has not been comprehensively audited.

Related Panagopoulos, Lai and Hardell publications are not independent replications.

Friedman et al. 2007 PMID 17456048 is PubMed-indexed RETRACTED and excluded.

Keep earlier 206-row research index alongside this curated, sourced selection.

Findings in cells/animals and associations in humans do not demonstrate general RF-related human illness.



ID	Theme	Authors	Year
E01	Cancer / tumor promotion	NTP	2018
E02	Cancer / tumor promotion	Falcioni et al.	2018
E03	Cancer / tumor promotion	Tillmann et al.	2010
E04	Cancer / tumor promotion	Lerchl et al.	2015
E05	Cancer / epidemiology	Hardell & Carlberg	2015
E06	Cancer / epidemiology	INTERPHONE Nordic analysis	2005
E07	DNA / genotoxicity	Lai & Singh	1995
E08	DNA / genotoxicity	Lai & Singh	1996
E09	DNA / genotoxicity	Lai & Singh	1997
E10	DNA / genotoxicity	Diem et al.	2005

E11	DNA / genotoxicity	Smith-Roe et al.	2020
E12	Panagopoulos / real-device bioeffects	Panagopoulos et al.	2007
E13	Panagopoulos / real-device bioeffects	Chavdoula et al.	2010
E14	Panagopoulos / real-device bioeffects	Panagopoulos et al.	2010
E15	Panagopoulos / real-device bioeffects	Panagopoulos et al.	2010
E16	Panagopoulos / real-device bioeffects	Margaritis et al.	2014
E17	Panagopoulos / real-device bioeffects	Manta et al. / collaborators	2017
E18	Mitochondria / redox	Xu et al.	2010
E19	Mitochondria / redox	Sun et al.	2017
E20	Mitochondria / redox	De Iuliis et al.	2009
E21	Reproductive / developmental	Avendaño et al.	2012

E22	Reproductive / developmental	Prenatal Wi-Fi rat study	2017
E23	Reproductive / developmental	Prenatal RF rat study	2020
E24	Reproductive / developmental	Cordelli et al.	2024
E25	Neurophysiology / behavioral	Huber et al.	2000
E26	Neurophysiology / behavioral	Volkow et al.	2011
E27	Neurophysiology / behavioral	Foerster et al.	2018
E28	Neurophysiology / behavioral	Röösli group	2015
E29	Blood-brain barrier	Salford et al.	2003
E30	Blood-brain barrier	Nittby et al.	2009
E31	Blood-brain barrier	BBB rat study	2011
E32	Epigenetics / methylation	Cantu et al.	2023

E33	Population / siting	Hutter et al.	2006
E34	Population / siting	Roosli et al. / questionnaire	2004
E35	Population / siting	Santini et al.	2003
E36	Wildlife / environment	Molina-Montenegro et al.	2023

Study / paper

Research design

Technical Report 595: 900 MHz cellular modulation
in rats

Primary experiment; 2-y rat bioassay

Ramazzini Institute lifespan base-station exposure

Primary experiment; Lifespan rat
bioassay

UMTS RF plus prenatal ethylnitrosourea tumor model

Primary experiment; ENU-treated mice

Tumor promotion by exposure below human SAR limits

Primary experiment; ENU-treated mice;
follow-up

Swedish pooled case-control glioma analysis

Primary experiment; Human case-control
pooled

Acoustic neuroma case-control study

Primary experiment; Human multicenter
case-control

Low intensity microwave and rat brain single-
strand breaks

Primary experiment; Rat brain cells

Single- and double-strand breaks in exposed rat
brains

Primary experiment; Rat brain cells

Antioxidants and RF-associated strand breaks

Primary experiment; Rat brain cells

Nonthermal DNA breakage in fibroblast and
granulosa cells

Primary experiment; Human fibroblast
and rat cell lines

NTP subchronic rodent genotoxicity	Primary experiment; Rats and mice; comet assay
Cell death induced by GSM 900/1800 mobile-phone signals	Primary experiment; Drosophila ovarian cells
Intermittent versus continuous GSM exposure	Primary experiment; Drosophila reproductive assay
Intensity and antenna distance in fruit-fly bioassay	Primary experiment; Drosophila reproductive assay
Daily exposure duration and Drosophila reproduction	Primary experiment; Drosophila
Drosophila oogenesis as an EMF bio-marker	Primary experiment; Drosophila; suite of 280 experiments
RF ovarian redox and gene-expression response in Drosophila	Primary experiment; Fruit-fly ovarian cells
Oxidative damage to mitochondrial DNA in cultured neurons	Primary experiment; Primary rat cortical neurons
Mitochondrial and oxidative changes in HL-60 cells	Primary experiment; Human leukemia cell line
Human sperm ROS and DNA fragmentation following RF	Primary experiment; Human sperm in vitro
Laptop Wi-Fi exposure to isolated human sperm	Primary experiment; 29 human donors; in vitro

Postnatal developmental effects in rats after gestational Wi-Fi	Primary experiment; Rat dams; 5 exposed, 5 control
Offspring development after 1800 MHz and Wi-Fi exposure	Primary experiment; Rat gestational model
Systematic review experimental RF male fertility	Systematic review; 117 animal papers and 10 human-sperm papers
Pulsed RF exposure and human sleep EEG	Primary experiment; Healthy adults; sham comparison
Cell phone on/off and human glucose metabolism	Primary experiment; 47 healthy adults; randomized crossover PET
Adolescent memory and modeled RF brain dose	Primary experiment; 669-676 adolescents; one-year cohort
Adolescent phone use and memory study	Primary experiment; 439 adolescents; 1-year follow-up
GSM RF and rat neuron injury markers	Primary experiment; Rat brain pathology
Albumin leakage 7 d after GSM exposure	Primary experiment; Rat brains
CW RF effects on Evans-blue BBB leakage	Primary experiment; Male and female rats
Keratinocyte whole-genome methylation after RF	Primary experiment; Human keratinocyte cultures

Measured bedroom RF and symptoms near base stations

Primary experiment; 365 residents; cross-sectional

Symptoms ascribed to EMF and mitigation actions

Primary experiment; Questionnaire respondents reporting symptoms

Base-station proximity and reported symptoms

Primary experiment; 530 people; survey

EMF and honeybee pollination

Primary experiment; Field/experimental honeybee study

Exposure

900 MHz GSM/CDMA; 1.5–6 W/kg whole body

1.8 GHz GSM far-field, prenatal to natural death

UMTS-modulated RF; chronic exposure

UMTS RF; sham, 0.04, 0.4, 2 W/kg

Self-reported mobile and cordless phone use; latency

Reported ipsilateral phone usage and duration

2.45 GHz pulsed/CW; ~0.6–1.2 W/kg

2.45 GHz pulsed and continuous; 1.2 W/kg

2.45 GHz RF; antioxidant pretreatment

1.8 GHz; 1.2 or 2 W/kg; different duty schedules

Cell-phone RF GSM/CDMA

GSM 900 and DCS 1800 commercial phone

GSM 900; equivalent cumulative 6-min daily exposure

GSM 900/1800 phone; 0-100 cm

GSM 900/1800; 1-21 min daily

Commercial mobile, DECT, Wi-Fi, Bluetooth and RF generator sources

Commercial mobile phone; mean SAR 0.15 W/kg; 30 min

1.8 GHz; 217 Hz modulation; 2 W/kg

900 MHz CW; 120 $\mu\text{W}/\text{cm}^2$; 4 h/day for 5 days

1.8 GHz; SAR 0.4-27.5 W/kg

Wi-Fi-connected laptop 4 h versus control

2.45 GHz Wi-Fi, 2 h/day pregnancy

1800 and 2400 MHz exposure

Multiple experimental frequencies/exposure systems

900 MHz; ~ 1 W/kg spatial peak; 30 min

Cell phone active versus inactive for 50 min

Personal modeled RF cumulative brain dose

Modeled cumulative brain/whole-body RF dose

GSM phone RF for 2h

900 MHz GSM; delayed measurements

0.9 and 1.8 GHz continuous RF, 20 min

900 MHz; estimated SAR < 0.01 W/kg; 1 h

Measured household levels near 10 base stations

Self-reported source categories and activities

Residential proximity and antenna facing

Anthropogenic electromagnetic exposure near
hives

Reported finding

Clear evidence of malignant heart schwannomas in males; some evidence malignant gliomas

Increased malignant heart schwannomas in exposed male rats at highest level

Reported cocarcinogenic/tumor-promoting signal

Higher lung/liver tumors and lymphomas in some exposed groups

Reported elevated glioma odds ratios, including longer latency groups

Longer ipsilateral use subgroup reported elevated odds despite null overall use

More strand-break signal at assessed post-exposure intervals

Reported increased single- and double-strand breaks

Melatonin/spin-trap compound reduced reported DNA effects

Comet-assay strand-break increases; intermittency stronger

Increased DNA damage in selected mouse and rat tissues;
other endpoints null

TUNEL DNA fragmentation and cell-death markers reported

Intermittent patterns affected reproduction and apoptosis
markers

Reported exposure-response windows and follicle cell death

Reproductive output declined with increasing duration

Reported follicle cell-death and fecundity effects varying
by source

ROS 1.6x; apoptotic follicles ~2x; 168 gene-expression
changes

Higher mitochondrial 8-OHdG; lower mtDNA copy
number/transcripts

Increased ROS/8-OHdG; decreased mtDNA transcripts/copy and
ATP

ROS, DNA fragmentation higher; motility/vitality lower with
SAR

Reduced progressive motility and increased DNA fragmentation

Reported early developmental and brain oxidative marker differences

Altered selected behavioral readouts and hippocampal receptor transcripts

Review reported moderate-certainty lower pregnancy rate in rodent outcomes, and low-certainty sperm-count reduction

Altered spectral power of subsequent non-REM EEG

Higher regional brain glucose metabolism near antenna

Association of greater dose with changes in figural memory

Higher estimated dose related to decline in certain memory outcomes

Reported neuronal damage in cortex/hippocampus/basal ganglia

Reported BBB permeability increases after exposure

Reported elevated albumin leakage in males only

Six targets both differentially methylated and expressed

Association with selected symptoms, notably headache

Sleep disorders/headaches common; two-thirds reported taking steps

Certain symptoms associated with position relative to tower

Reported altered pollination service and organism stress indicators

Research rationale

Controlled, multi-year, federally funded mammalian tumor findings warrant replication

Independent institution observed analogous tumor histology in different exposure geometry

Direct experimental test of RF as promoter rather than sole carcinogen

Promotional effects reported at 0.04/0.4 W/kg; targeted replication warranted

Motivates histology-specific epidemiology with objective usage/exposure history

Supports tumor-specific laterality/latency analytic designs

Early controlled DNA endpoint; NIH grant indexed in PubMed

Expands endpoint and waveform testing

Intervention/control tests oxidative mechanistic pathway

Supports testing waveform/duty-cycle factors, beyond average exposure

Federal controlled testing with tissue-specific signal;
available raw data

Useful real-device experimental model and biological endpoint

Directly tests temporal exposure patterns

Supports matched physical dosimetry rather than distance-only
assumptions

Supports time resolved and cumulative dose research

Comparison across device/waveform classes within a biological
model

Specific multiplex biological endpoints at measured nominal
SAR

Direct RF-associated mitochondrial endpoints, antioxidant-
control design

Mitochondrial function plus redox indicators; therapeutic-
control concept

Links mitochondrial ROS and germ-cell endpoints with SAR
series

Real-world device condition as screening study for controlled
trials

Specific offspring outcome endpoints for more powered
preregistered studies

Provides plausible markers to replicate with larger cohorts

Outcome-specific external evidence synthesis; identifies
protocol deficiencies

Human physiological endpoint with reversible/crossover style
measures

Direct objectively measured acute human physiology

Motivates repeated adolescent cohorts with dosimeter
validation

Independent time-based observational exposure model useful
for protocols

Potential blood-brain-barrier and neuronal endpoints for
blinded replication

Delayed exposure-outcome follow-up feasible and testable

Sex-stratified replication question and mechanistic
hypothesis

Strong endpoint specificity; motivates genome-wide
replication and methylation pathways

Couples actual environmental measurements with symptom data

Social functioning and burden measurement justification

Directional geometry deserves independent prospective evaluation

Wildlife/ecosystem endpoint to verify independently

Limitations / unresolved

Animal whole-body high doses; not direct human environmental risk

Tumor rarity and histology-specific interpretation; full dosimetry review needed

Combined carcinogen exposure; interaction design; not proof of spontaneous tumor increase

No consistent dose response; collaborating institutions overlap earlier work

Recall and selection biases; overlapping datasets; not cohort confirmation

Subgroup finding; recall bias and overall null association

Single laboratory; methodological and thermal control review needed

Same research group; replication needed

Does not establish dietary clinical benefit or human injury

In vitro; replication and dosimetry controversies merit independent protocol

Tissue/modulation specificity; absence of micronucleus effect

Insects; device characterization and independent mammal/human confirmation required

Same investigator network; insect outcomes

Phone near insect preparation not tower siting data; erratum indexed

Insect endpoints, single researcher group

Related investigator network; many experiments not independent publications

Same broad Athens research program; biological relevance to humans undetermined

No sequence-level heritable mutations; cell culture and higher SAR

Transformed cells; CW lab conditions; no germline data

Substantial high-dose range and in-vitro conditions; paternal not maternal mtDNA inheritance

Laptop can add thermal/electrical confounds; in vitro cannot prove fertility changes

Very small maternal group; not mtDNA inheritance

Animal setting, developmental outcome confounding and multiple comparisons

Systematic review not a primary experiment; effect estimates vary and bias is common

EEG differences not clinical injury

Clinical significance uncertain; not evidence for disease

Residual phone-use confounding; observational

Exposure estimates and non-RF phone use confounding

Histology limitations; effects contested in follow-up research

Results inconsistent across laboratories

Short-term animal-only and contested BBB literature

Acute cell-culture marker, not MTHFR metabolism or clinical disease

Cross-sectional confounding and no established causality

Selected self-report sample; no RF causal inference

No individual dosimetry/strong confounding; not siting
threshold

Field exposure mixtures and ecological confounding

https://pubmed.ncbi.nlm.nih.gov/33562898/	10;12;15
https://pubmed.ncbi.nlm.nih.gov/29530389/	9;10;12
https://pubmed.ncbi.nlm.nih.gov/20545575/	10;12
https://pubmed.ncbi.nlm.nih.gov/25749340/	10;12
https://pubmed.ncbi.nlm.nih.gov/25466607/	10;12
https://pubmed.ncbi.nlm.nih.gov/16136046/	10;12
https://pubmed.ncbi.nlm.nih.gov/7677797/	10;12
https://pubmed.ncbi.nlm.nih.gov/8627134/	10;12
https://pubmed.ncbi.nlm.nih.gov/9261542/	10;12;15
https://pubmed.ncbi.nlm.nih.gov/15869902/	5;10;11;12

https://pubmed.ncbi.nlm.nih.gov/31633839/	10;12
https://pubmed.ncbi.nlm.nih.gov/17045516/	5;7;10;11
https://pubmed.ncbi.nlm.nih.gov/20472095/	5;7;11
https://pubmed.ncbi.nlm.nih.gov/20397839/	5;7;9
https://pubmed.ncbi.nlm.nih.gov/20399887/	5;7;11
https://pubmed.ncbi.nlm.nih.gov/23915130/	5;7;11
https://pubmed.ncbi.nlm.nih.gov/27960592/	10;11;12
https://pubmed.ncbi.nlm.nih.gov/19879861/	10;15
https://pubmed.ncbi.nlm.nih.gov/28340409/	10;15
https://pubmed.ncbi.nlm.nih.gov/19649291/	10;15
https://pubmed.ncbi.nlm.nih.gov/22112647/	7;10;15

<https://pubmed.ncbi.nlm.nih.gov/28458069/> 10;15

<https://pubmed.ncbi.nlm.nih.gov/31927574/> 10;15

<https://doi.org/10.1016/j.envint.2024.108509> 10;15

<https://pubmed.ncbi.nlm.nih.gov/11059895/> 4;10;11

<https://pubmed.ncbi.nlm.nih.gov/21343580/> 4;10;11

<https://pubmed.ncbi.nlm.nih.gov/30044230/> 1;10;15

<https://pubmed.ncbi.nlm.nih.gov/26474271/> 1;10;15

<https://pubmed.ncbi.nlm.nih.gov/12782486/> 10;15

<https://pubmed.ncbi.nlm.nih.gov/19345073/> 10;15

<https://pubmed.ncbi.nlm.nih.gov/22047463/> 10;15

<https://pubmed.ncbi.nlm.nih.gov/36999566/> 10;12

<https://pubmed.ncbi.nlm.nih.gov/16621850/> 1;9;11

<https://pubmed.ncbi.nlm.nih.gov/15031956/> 1;2;3

<https://pubmed.ncbi.nlm.nih.gov/12948762/> 9

<https://pubmed.ncbi.nlm.nih.gov/37172085/> 12

Not audited study-by-study; verify grants, affiliations, contracts and indirect support [Open study](#)

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Source	Type
Panagopoulos, ed. (2022)	Book/publisher TOC
Google Books Panagopoulos	Limited preview
Moskowitz / Henry Lai (Jun 2026)	Research bibliography
Original 206 historical rows	Prior ChatGPT research register
NTP TR595	Federal primary report
2024 Cordelli review	Systematic review

Counts/coverage

Chapters on oxidative stress, genotoxicity, reproduction,
brain, EHS, wildlife, channels

2022 edition

390/438 oxidative; 396/550 genetic; 396/507 neurological;
354/415 reproductive

100 initial ROS + 43 addl redox + 63 mitochondrial

Long-term rat cancer and genetic testing

117 animal fertility + 10 human sperm in vitro papers

Verification & limits

Full book text NOT accessed; contents/limited preview only

Partial preview only

Lai's compiled significant-effect counts are NOT pooled evidence of causation or independently audited

May overlap, contain lower-quality records and non-RF ELF; full audit not yet complete

Standardized federal technical report; animal whole-body exposures

Outcome-specific positive results and significant risk of bias

Direct URL

<https://www.routledge.com/link/link/p/book/9781032061764>

https://books.google.com/books/about/Electromagnetic_Fields_of_Wireless_Communication.html?id=QHagEAAAQBAJ

<https://www.saferemr.com/2018/02/effects-of-exposure-to-electromagnetic.html>

<https://ntp.niehs.nih.gov/publications/reports/tr/tr595>

<https://doi.org/10.1016/j.envint.2024.108509>

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Priority	Gap / issue
Immediate	Retracted publications
Immediate	Funding provenance
Immediate	Study overlap
Immediate	Exposure controls
High	Panagopoulos book
High	Moskowitz/Lai compilations
High	Tumor promotion
High	Neurologic & BBB
High	mtDNA in reproduction
High	Methylation pathways
High	Human function & burden
High	RF siting & environmental exposure

High

Adjustable RF transmitters

Required verification

Verify PubMed notices, Crossmark corrections and retractions for all 36 cited items

Review acknowledgements, sponsor roles, telecom/FCC contractors, affiliations and funders for each record

Identify same data/subjects/authors and replicated vs reanalyzed reports

Review actual SAR/power/time/temp/sham/duty/field validity and operator blinding

Obtain licensed chapter pages / reference bibliographies; source-verification with permission

Download and screen named PDFs, isolate RF vs ELF, deduplicate the records, quality rate

Replicate ENU promotion with independent laboratories and full tumor histopathology

Replicate human PET/EEG and rat BBB evidence with calibrated exposures

Oocyte DNA sequencing, multigenerational maternal mtDNA tracking and heteroplasmy

Genome-wide replication plus folate cycle/one-carbon metabolites; separate MTHFR speculation

Longitudinal study with optional current monitoring without retrospective diary requirements

Measure antenna main-lobe geometry, indoor levels and beamforming activity

Field trials with low-power mode, Wi-Fi off and scheduling; device reliability and energy usage

Potential HHS outcome

Exclude invalid references from docket

Independent and industry-affiliated evidence strata

Avoid inflated independent study count

Select replication-ready studies

Expand curated citations beyond available abstracts

Build a systematic HHS grant evidence map

Fundable animal study protocols

Detect measurable pathway effects vs clinically relevant outcomes

Test heritability hypothesis

Test methylation mechanism

Quantify prevalence, disability, and costs

Evidence-based siting standards

Consumer controls with actual emission reduction