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Static/ELF EMF Studies that reported effects at low flux densities (≤ 0.01 mT (10 μT))

Henry Lai, Ph.D.

A = acute exposure; C = chronic/repeated exposure; CE= cellular effect; ELF= extremely low frequency; G= genetic effects; HU= human study; M= morphological effect; N= neurological effects (including behavior); O =oxidative effects; P =physiological effects; SMF= static magnetic field; VO= in vivo; VT= in vitro

Agliassa et al. (2018)	0.00004 mT	SMF, VO, G, C
Albaqami et al. (2020)	0.0002 mT	SMF (hypomagnetic field), VO, G, A
Back et al. (2019)	<0.005 mT	SMF (hypomagnetic field), VT, G, C
Baraúna et al. (2015)	0.00066 mT	ELF, VO, G, A
Bediz et al. (2006)	0.005 mT	50 Hz, VO, O, C
Bobkova et al.(2018)	0.00008 mT	ELF, VO, N, C
Branigan et al. (2026)	0.004 mT	ELF, HU, A, N
Budziosz et al. (2018)	4.4 pT	50 Hz, VO, O, C
de Kleijn et al. (2016)	0.01 mT	20-500 Hz; VO, G, C
De Roos et al. (2001)	0.0004 mT	ELF, HU, C, paternal exposure increased neuroblastoma in offspring
Ding et al. (2019)	0.0005 mT	SMF (hypomagnetic field), VO, N, A
Dominici et al. (2011)	0.00781 mT	ELF, HU, G, C
Fournier et al. (2012)	0.00004 mT	50 Hz, VO, N, C
Ghassemkhani and Dotta (2025)	0.001 mT	ELF, N, VO, A
Gholamian-Hamadan et al. (2023)	0.001 mT	50 Hz; VO, G, C
Goodman et al. (1994)	0.008 mT	60 Hz, VT, G, A
Guillebon et al (2024)	0.000126 mT	ELF, AE, M, VO
Gurhan et al. (2021)	0.0005 mT	SMF, VT, CE, O, C
Hashish et al. (2008)	0.0029 mT	SMF, VO, CE, O, C
Heredia-Rojas et al. (2010)	0.008 and 0.00008 mT	60 Hz, VT, G, A

Heredia-Rojas et al. (2018)	0.0088 mT	60 Hz, A, G, VO
Hermans et a (2025)	0.0018-0.0046 mT	50 Hz, VO, C, N
Jadidi et al. (2017)	0.001 mT	50 Hz, VO, P, C
Juutilainen et al. (1987)	Threshold at 0.0012 mT	50 Hz, C, P, VO
Karimi et al. (2019)	0.001 mT	50 Hz, VO, O, C
Kazemi et al. (2018)	0.0007 mT	1 or 12 Hz, VO, G, N, C
Kazemi et al. (2022a)	0.0007 mT	12 Hz, VO, G, N, C
Kazemi et al. (2022b)	0.0007 mT	12 Hz, VO, G, N, C
Krylov et al. (2024)	0.00198-0.0032 mT	1.44-3 Hz, A, P, VT
Lai and Singh (2004)	0.01 mT	60 Hz, VO, G, A
Li et al. (2012)	0.00015 - 0.00025 mT	ELF, HU, P, C
Li and Héroux (2014)	0.000025-0.05 mT	ELF, VT, CE, A
Liboff et al. (1984)	0.005-0.025 mT	15 Hz-4 kHz, VT, G, A
Lin H et al. (1998)	0.008 mT	60 Hz, VT, G, A
Lin H et al. (1999)	0.008 mT	60 Hz, VT, G, A
Lupi et al. (2020)	0.0015 mT	50 Hz, VO, O, C
Mahaki et al. (2019)	0.001 mT	50 Hz, VO, G, C
Mahdavinejad et al. (2018)	0.001 mT	50 Hz, VO, G, C
Martino and Castello (2011)	0.0002-0.002 mT	SMF, VT, O, A
Monirul Islam et al. (2020)	0.00003 mT	SMF (hypomagnetic field), VO, G, C
Murugan and Persinger (2014)	0.005 mT	ELF, VO, N, A
Navarro and Navarro-Modesto (2023)	0.0001 mT	ELF-VLF (20 Hz-20 KHz), HU. N, A
Nishimura et al. (2011)	0.001 mT	ELF, HU, P, C
Pilla (2012)	0.0025 mT	2 Hz pulses, VT, O, A

Prato et al. (2013)	0.044 mT (SMF); 0.000033 mT (30 Hz)	C, ELF, N, AMF, VO
Rao and Handerson (1996)	0.006 mT	60 Hz, VT, G, A
Regoli et al. (2005)	0.000288- 0.00075 mT	50 Hz, VO, O, C
Ross ML et al. (2008)	0.00001 mT	7-10 Hz, HU, N, A
Ross CL et al. (2016)	0.0015 mT	5 Hz, VT, CE, A
Sarimov et al. (2011)	0.005-0.02 mT	50 Hz, VT, G, A
Scherlag et al. (2004)	0.000000287 mT	0.043 Hz, VO, P, A
Sieroń et al. (2021)	4.3 pT	50 Hz, VO, O, C
Sobhanifard et al. (2019)	0.001 mT	50 Hz, VO, G, C
Stevens (2007)	0.005 mT	8-12 Hz, HU, N, A
Tachibana et al. (2024)	0.01 mT	1-8 Hz, C, HU, N, VO
Teranishi et al. (2024)	0.01 mT	1-8 Hz, C, N, O, VO
Tian et al. (2022)	0.000031 mT	SMF (hypomagnetic field), VO, G, N, O, C
Tipping et al. (1999)	0.008 mT	50 Hz, VO, G, A
Villarini et al. (2015)	0.0078 mT	ELF, HU, G, C
Wahab et al. (2007)	0.001 mT	50 Hz, VT, G, A
Xu C et al. (2012)	Near-null (0.00001 mT)	SMF (hypomagnetic field), VO, G, C
Xu C et al. (2021)	Near-null (0.00001 mT)	SMF (hypomagnetic field), VO, G, C
Zastko et al. (2025)	0.008 mT	A, ELF, G. VT
Zendehdel et al. (2019)	0.00085 mT.	ELF, HU, G, C
Zhan et al. (2022)	0.000031 mT	SMF (hypomagnetic field), VO, O, C
Zhang J. et al. (2018)	0.0005 mT	SMF, VT, O, C
Zhang Y et al. (2022)	0.000523 mT	SMF (hypomagnetic field), VO, G, C

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Some ELF-magnetic fields measurements in various locations

Abuashi et al (2018)	Residential exposure in City of Ramallah-Palestine	81% exposure <0.0001 mT, highest mean MF = 0.00045 mT
Al-Badi (2012)	Various locations in Oman power system: overhead lines, underground cables, and sub-stations	Highest in grid stations and sub-stations- 0.018 mT; in areas where general public could be exposed to at boundaries of sub-station- 0.016 mT
AL-rajhi (2014)	Close to underground transmission lines in Riyadh	Mean 0.00516 mT (range 0.0001- 0.0197 mT)
Eskelinen et al (2002)	Residential measurements from 27 subjects in Kuopia, Finland	24-h measurement mean level- 0.00077 mT
Ilonen et al (2008)	Apartments close to indoor transformer stations in 30 buildings in three cities in Finland	24-h measurement means: 0.00062 mT in apartment above a transformer station; 0.00021 mT in one first floor reference apartment, 0.00011 mT in one reference apartment on upper floors.
Kiouvrekis et al. (2021)	243 schools in Greece, 1Hz-400KHz	Mean values from all he sampled schools was 0.00021 mT
Lindgren et al. (2001)	Measurements in Goteborg, Sweden	50% of investigated streets- 0.0002 mT and above, > 0.001 mT in areas close to distribution pillars. Power substations, shoplifting alarms, and other electrical devices.
Park et al. (2023)	Semiconductor factory in Republic of Korea	Workers can be exposed to ELF MF of 0.0025 - 0.0036 mT
Röösli et al. (2011)	39 apartments in 18 buildings with transformer statins in Zurich, Switzerland	0.00059 mT in apartments adjacent to transformer room, 0.00014 mT in apartments partly adjacent to a transformer room, 0.0001 mT in other apartments.
Yitzhak et al. (2012)	Apartment building in Israel with indoor transformer station.	0.00033 mT in apartment above transformer.

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