DEP Lazio
Dipartimento di Epidemiologia del Servizio Sanitario Regionale
Regione Lazio

Esposizione a campi elettromagnetici a bassa ed alta frequenza e rischi per la salute

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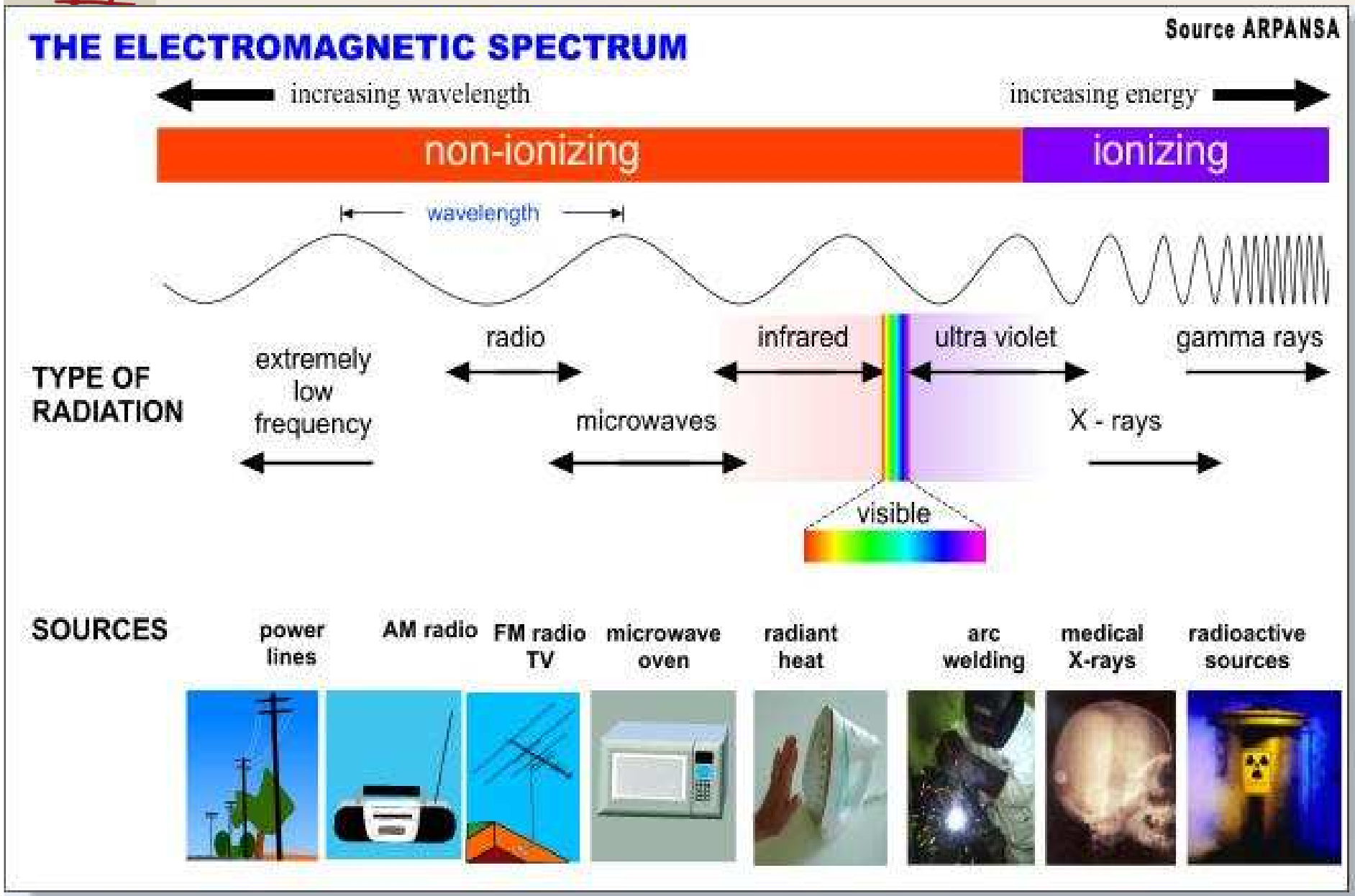
Università degli studi di Brescia, Seminari di Sanità Pubblica, V Edizione, 2012

I campi elettromagnetici

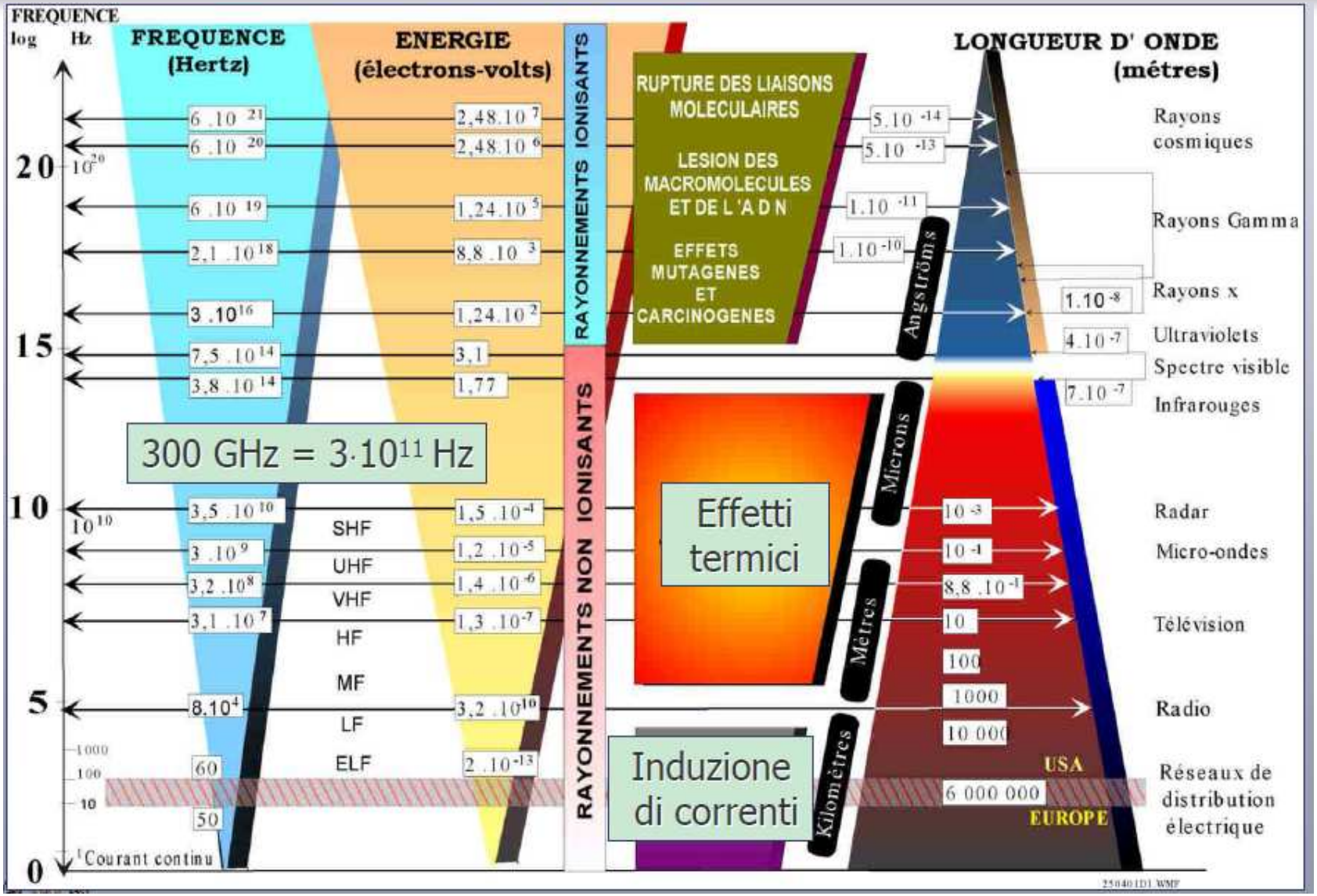
Campi elettrici	Campi magnetici
1. I campi elettrici derivano dalla tensione 2. La loro intensità si misura in volt al metro (V/m) 3. Un campo elettrico può essere presente anche se un apparecchio è spento 4. L'intensità del campo elettrico diminuisce con la distanza dalla sorgente 5. La maggior parte dei materiali scherma in qualche misura i campi elettrici	1. I campi magnetici derivano dalla corrente elettrica 2. La loro intensità si misura in ampere al metro (A/m). Generalmente, i ricercatori usano al suo posto una grandezza associata, l'induzione magnetica (di solito misurata in microtesla, μT, o in millitesla, mT) 3. I campi magnetici esistono solo se un apparecchio è acceso e circola una corrente 4. L'intensità del campo magnetico diminuisce con la distanza dalla sorgente 5. I campi magnetici non sono schermati dalla maggior parte dei materiali

Fonte: WHO, What are electromagnetic fields? http://www.who.int/peh-emf/about/WhatisEMF

I campi elettromagnetici



I campi elettromagnetici



L’inquinamento ambientale da **CEM** è riconducibile a due tipologie di infrastrutture presenti in aree urbanizzate: gli elettrodotti ad alta tensione, che generano campi elettrici e magnetici a frequenze **estremamente basse (50 Hz)**, e gli impianti per telecomunicazione, che irradiano campi elettromagnetici ad alte frequenze **(radiofrequenze)**

Esposizione a campi elettromagnetici e salute

Secondo una recente ricerca dell'EU del 2010* due terzi dei cittadini europei sono convinti che

l'esposizione a campi elettromagnetici

da linee ad alta tensione, telefoni cellulari e stazioni radio-base abbia importanti effetti negativi sulla salute

*TNS, Opinion and social, electromagnetic fields. Special Eurobarometer, Brusselles, 2010

Campi elettromagnetici e percezione del rischio, (WHO. 1998)

Esposizione involontaria

Mancanza di controllo personale

Rischio non familiare (situazione o la tecnologia nuova, di difficile comprensione)

Rischio drammatico (Malattie e infermità gravi, come il cancro)

Condizione non equa

Informazione scientifica insufficiente

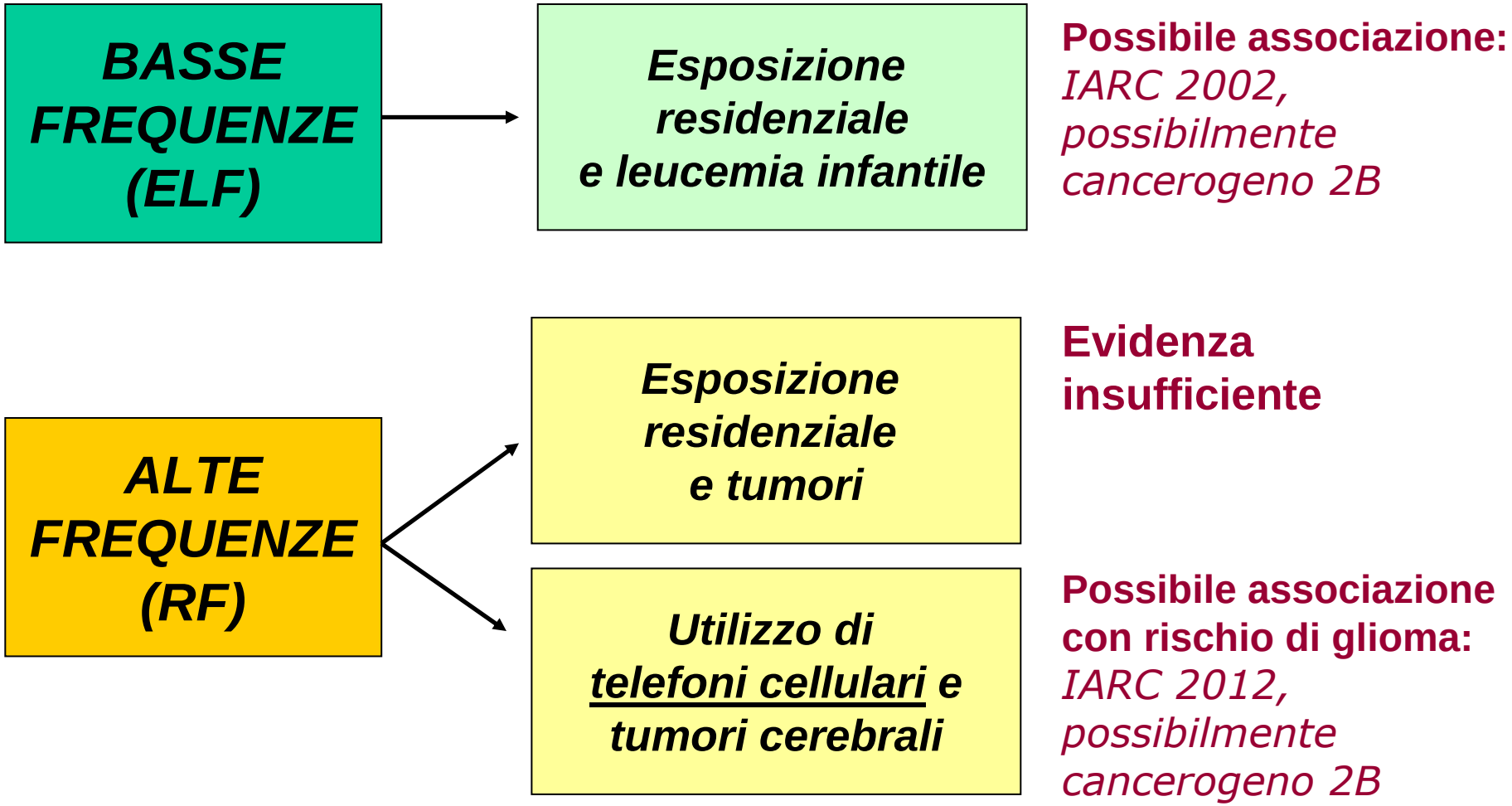
Ma qual è la posizione della scienza ufficiale ?

International Commission on non-ionizing radiation protection (ICNIRP)

Organizzazione Mondiale della Sanità (WHO)

Agenzia Internazionale per la Ricerca sul Cancro (IARC)

Valutazioni della IARC




Campi statici e a frequenza
estremamente bassa (ELF)
e rischi per la salute

Le fonti

Fonti naturali

Campo magnetico terrestre=
da 60 μT ai poli a 30 μT vicino all'equatore.
Nelle regioni temperate è ~45–50 μT e soggetto a variazioni giornaliere, lunari e stagionali;

Campo elettrico dell'atmosfera = ~100 V/m, può variare tra 50–500 V/m in base al clima, altitudine, ora del giorno e stagione

Fonte: WHO, IARC Monograph Volume 80, 2002.

Le fonti

Fonti di origine antropica
Esposizione residenziale

- ***"background" :*** rete di distribuzione e linee elettriche. Media aritmetica: 0,11 μT (USA) e 0,05 μT (UK)
- ***Apparecchi elettrici:*** campi più intensi ma temporanei, diminuiscono con la distanza

Apparecchi elettrici	5 cm	50 cm
Lavastoviglie	6 μT	0,8 μT
Frullatore	70 μT	0,7μT
Rasoio elettrico	165μT	0,8 μT

Fonte: WHO, IARC Monograph Volume 80, 2002.

Le fonti

- **linee elettriche ad alta tensione*:*** voltaggio =120 V (USA), 220-240 V (Europa), fino ad un max=765 kV
  Produzione di un campo elettrico con intensità massima sotto la linea elettrica (11 kV/m per linee a 400 kV), si riduce per azione schermante da parte di oggetti, vegetazione, edifici.
  Produzione di un campo magnetico con intensità massima sotto le linee (10 μT per linee a 380 kV), decade a distanza 50-100 m dalla linea (in base alle caratteristiche strutturali, tipo di corrente e intensità del background).
- **cabine elettriche di trasformazione**: produzione di un un campo magnetico di 10-30 μT nel locale sovrastante.

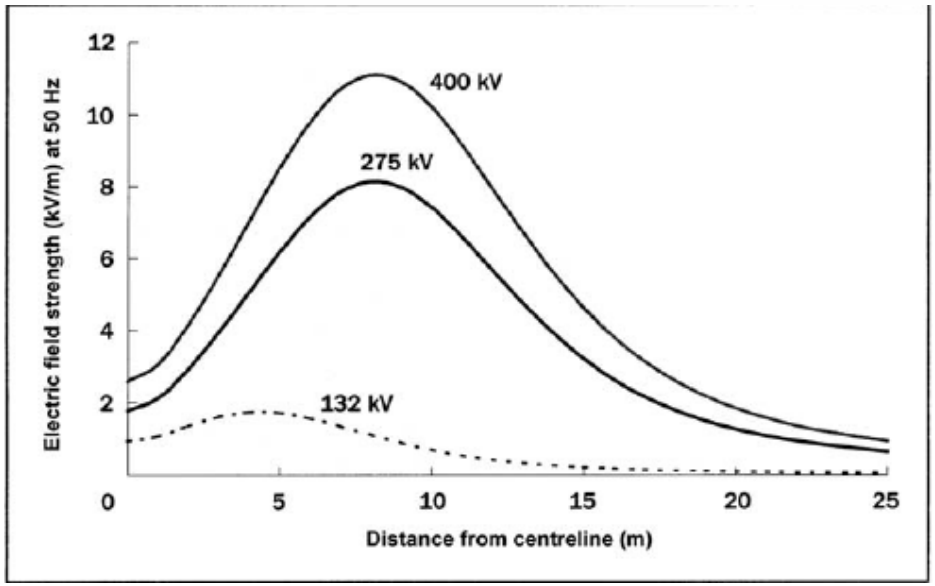
Fonte: WHO, IARC Monograph Volume 80, 2002.

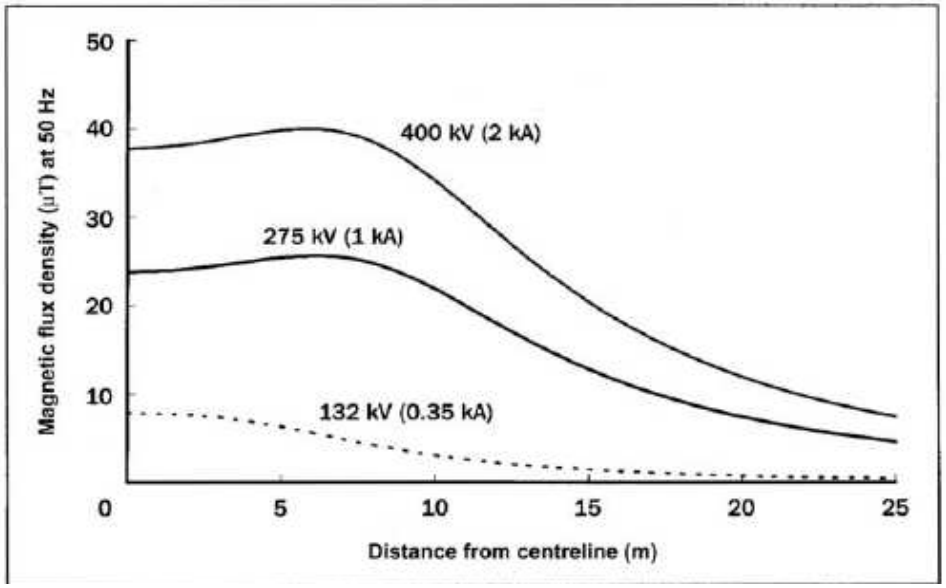
Le fonti

- **Esposizione nelle scuole,** dovuta a background, linee elettriche nell'edificio, apparecchi elettrici nei locali interni, vicinanza a linee ad alta tensione.

Fonte: WHO, IARC Monograph Volume 80, 2002.

Campo elettrico e magnetico e distanza dalle linee elettriche ad alta tensione





Campo elettrico

- intensità massima sotto la linea elettrica
- si riduce per azione schermante da parte di oggetti, vegetazione, edifici

Campo magnetico

- intensità massima sotto le linee
- decade a distanza 50-100 m dalla linea *(in base alle caratteristiche strutturali, tipo di corrente e intensità del background)*

Circa l'1% della popolazione è esposta. Fonte: IARC 2002

Le fonti

Esposizione occupazionale

- Industria di fornitura di energia elettrica

Diretta o indiretta (vicinanza del luogo di lavoro alle linee elettriche)

Mansione lavorativa	Esposizione media
addetti alla centrale elettrica	0,18-1,72 μT
addetti alla linea elettrica	0,03-4,57 μT
elettricisti	0,2-18,48 μT

Fonte: WHO, IARC Monograph Volume 80, 2002.

Le fonti

- Addetti alla saldatura

Diretta: 100-200 μT

- Addetti alle fornaci e al riscaldamento a induzione

Mansione lavorativa	Esposizione media (< 1 metro)
Addetti alle fornaci	0,1-0,9 mT per correnti di 50 Hz
Addetti al riscaldamento a induzione	1-60 mT da 50-10 kHz

Fonte: WHO, IARC Monograph Volume 80, 2002.

Le fonti

- Trasporto elettrico (treni, aeroplani, macchine elettriche). Es. Macchinista treno = 25 to 120 μT

- Addetti ai videoterminali

Esposizione tra 0,03 a 0,21 μT per frequenze tra 15 e 35 kHz

- Uso di macchine da cucire: tra 0.32–11.1 μT

Esposizioni accidentali (corto circuito, fulmini)

Fonte: WHO, IARC Monograph Volume 80, 2002.

Meccanismi biologici

Possibili **meccanismi diretti**:

-Campi elettrici indotti nei tessuti influenzano l'elaborazione di segnali ambientali molto deboli (es. nelle sinapsi del tessuto nervoso)

-Prolungamento della vita di coppie di radicali liberi (per campi a bassa intensità)

-Effetti sulle particelle magnetiche (cristalli di magnetite) presenti in tracce nel cervello umano

Tuttavia, sono plausibili a intensità più elevate di quelle a cui è normalmente esposta la popolazione

Meccanismi indiretti poco studiati (es. le linee ad alta tensione aumentano la deposizione di inquinanti atmosferici sulla pelle e nelle vie aeree, potenziandone gli effetti sulla salute)

Studi sperimentali

Effetti acuti

Sono stati accertati effetti biologici acuti che potrebbero avere conseguenze nocive per la salute, a seguito di esposizioni a campi elettrici e magnetici di frequenza fino a 100 kHz (limiti di esposizione)

Effetti cronici

tutti i dati di laboratorio o relativi ai meccanismi di interazione non forniscono sostegno a un'associazione tra campi magnetici ELF di bassa intensità e variazioni delle funzioni biologiche o stati patologici


Campi statici e a frequenza estremamente bassa (ELF): effetti sui lavoratori

Coorti occupazionali di lavoratori esposti a ELF e incidenza di leucemia

Studio	Paese	Occupazione	Risultati
Tornqvist 1986	Svezia	addetti linee elettriche	SIR=1.3 (0.7-2.1)
Garland 1990	USA	elettricisti	SIR=2.4 (1.0-5.0)
Juutilainen 1990	Finlandia	lavoratori esposti	RR=1.4 (1.1-1.8)
Tynes 1992	Norvegia	lavoratori esposti	SIR=1.8 (1.1-2.8) relazione dose-risposta
Guenel 1993	Danimarca	lavoratori esposti	SIR=1.6 (1.2-2.2) uomini SIR=0.56 (0.07-2.0) donne
Floderus 1994	Svezia	lavoratori linee ferroviarie	SIR=2.7 (1.0-7.4)
Tynes 1994	Norvegia	addetti compagnie energia idroelettrica	SIR=0.90 (0.45-1.6)
Savitz 1995	USA	addetti compagnie energia elettrica	SIR=2.5 (1.1-5.8)
Alfredsson 1996	Svezia	macchinisti linee ferroviarie	RR=1.6 (0.9-2.6)
Johannsen 1998	Danimarca	addetti compagnie energia elettrica	nessun rischio
Floderus 1999	Svezia	lavoratori esposti	RR=1.1 (1.0-1.2) uomini RR=1.1 (1.0-1.4) donne
Pira 1999	Italia	addetti impianti elettrici geotermali	SMR=0.79 (0.34-1.6)
Harrington 2001	UK	addetti linee elettriche	RR=1.4 (0.68-2.8)
Minder 2001	Svizzera	addetti linee ferroviarie	RR=2.4 (0.97-6.1)
Hakansson 2002	Svezia	addetti saldatura a resistenza	RR=1.8 (0.4-8.5) donne uomini nessun rischio

Coorti occupazionali di lavoratori esposti a ELF e incidenza di tumori cerebrali

Studio	Paese	Occupazione	Risultati
Tornqvist 1986	Svezia	addetti linee elettriche	SIR=1.5 (0.9-2.4)
Tynes 1994	Norvegia	addetti compagnie energia idroelettrica	SIR=0.88 (0.47-1.5)
Savitz 1995	USA	addetti compagnie energia elettrica	SIR=2.3 (1.2-4.6)
Johannsen 1998	Danimarca	addetti compagnie energia elettrica	nessun rischio
Floderus 1999	Svezia	lavoratori esposti	RR=1.1 (1.0-1.2) maschi, RR=0.9 (0.8-1.1) femmine
Pira 1999	Italia	lavoratori impianti elettrici geotermali	SMR=1.2 (0.57-2.1)
Minder 2001	Svizzera	addetti linee ferroviarie	RR=5.1 (1.2-2.1)
Hakansson 2002	Svezia	addetti saldatura a resistenza	RR=9.8 (1.1-86.2) uomini, RR=1.9 (0.9-3.9) donne
Navas-Acien 2002	Svezia	lavoratori esposti (uomini)	OR=1.1 (0.9-1.2)
Wesseling 2002	Finlandia	lavoratori esposti (donne)	SIR=1.4 (0.9-2.1)


Campi statici e a frequenza estremamente bassa (ELF): esposizione residenziale e leucemia infantile

Stime pooled su ELF e incidenza di leucemia infantile in ambito residenziale

Autore	N°studi inclusi	Casi esposti n (%)	Risultati (95% CI)*	
Ahlbom 2000	9 caso-controllo	44 (1%)	≥0.4 μT vs < 0.1 μT:	**OR=2.00 (1.27-3.13)**
Greenland et al., 2000	15 caso-controllo	99 (3%)	≥0.3 μT vs < 0.1 μT:	**OR=1.7 (1.2-2.3)**
Schuz 2007	6 caso-controllo	23 (1%)	≥0.4 μT vs < 0.1 μT: (misurazioni nella camera da letto del bambino)	**OR=1.93 (1.11-3.35)**
Kheifets 2010a	7 caso-controllo	26 (0.2%)	≥0.3 μT vs < 0.1 μT:	**OR=1.44 (0.88-2.36)** trend significativo

Su cui si basa la Valutazione IARC 2002

Stime pooled su ELF e incidenza di tumori cerebrali infantili in ambito residenziale

Autore	Tipo di studio	Casi esposti n (%)	Risultati (95% CI)*	
Mezei et al. 2008	13 studi caso-controllo e coorte	19 (1.6%)	≥0.3 o 0.4 μT vs < 0.1 μT	OR=1.68 (0.83-3.43)
			Distanza <50m vs ≥50m	OR=0.88 (0.57-1.37)
Kheifets 2010b	10 studi caso-controllo e coorte	27 (0.3%)	≥0.4 μT vs < 0.1 μT:	OR=1.14 (0.61-2.13) trend non significativo

Possibili spiegazioni dell'associazione tra ELF e leucemia infantile

Consistente evidenza epidemiologica di una associazione tra ELF 0.3-0.4 μT e leucemia infantile

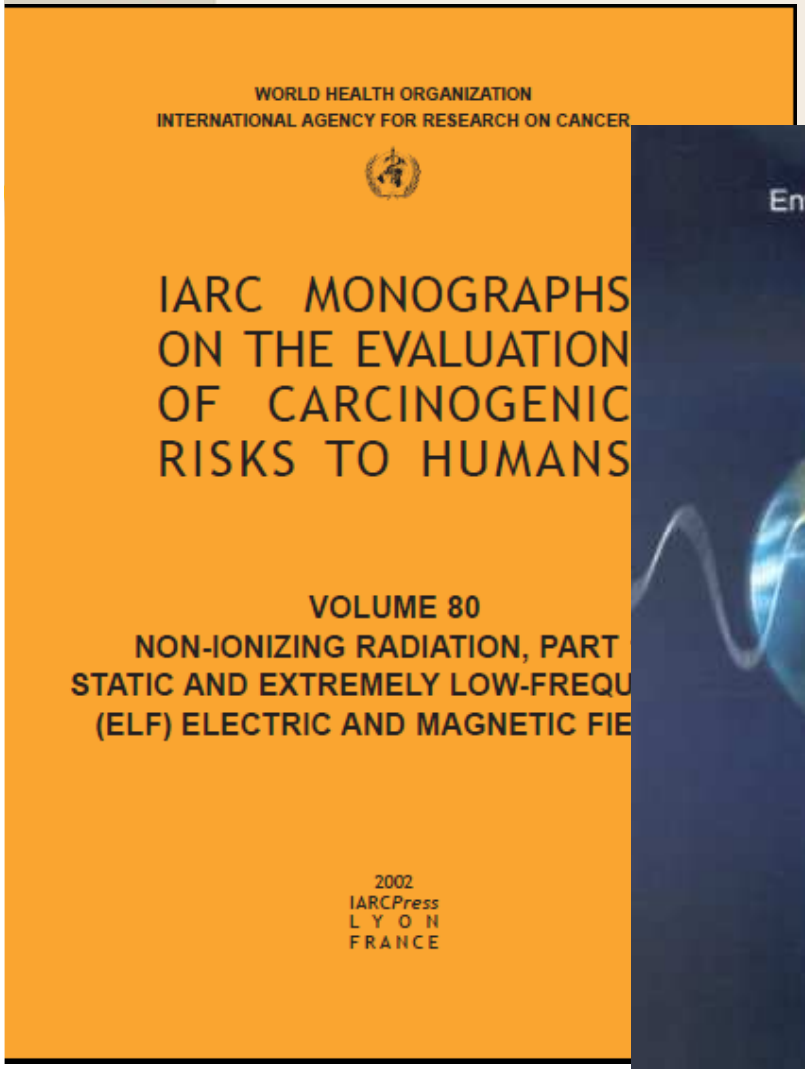
MA:
Nessuna evidenza sperimentale

Nessun meccanismo stabilito a supporto dell'ipotesi causale

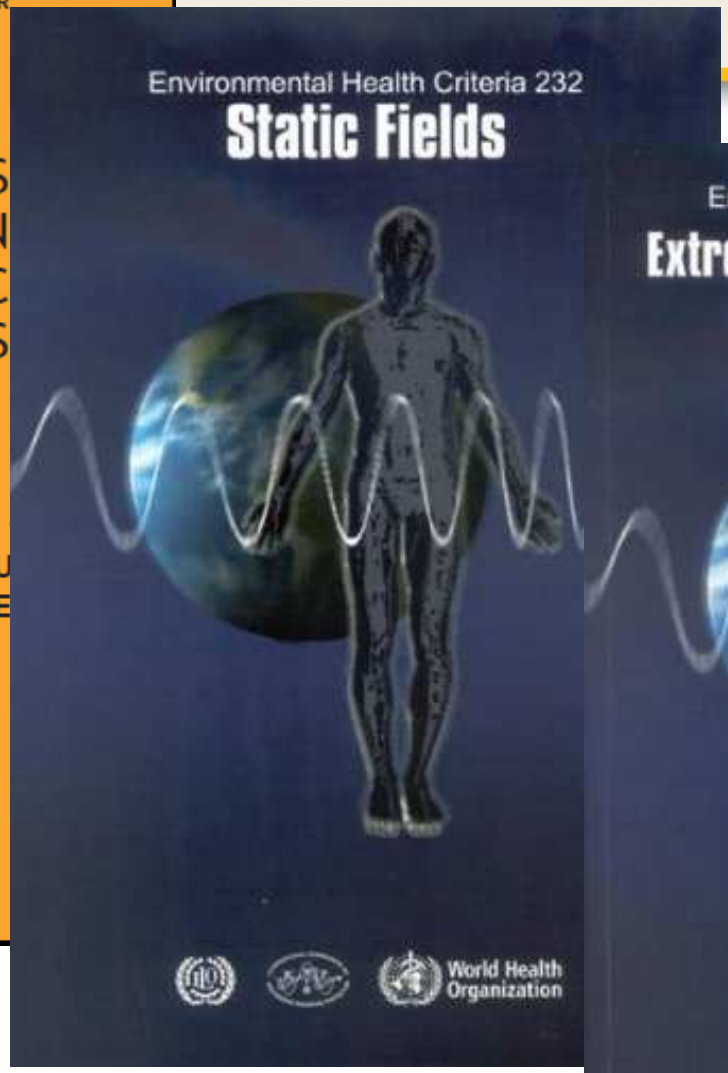
- **associazione CAUSALE**
  - Iniziazione tumorale
  - Promozione tumorale
  - Meccanismi epigenetici
- **artefatto statistico**
  - errore casuale
  - bias di selezione
  - misclassificazione esposizione
  - confondimento
- **spiegazioni alternative**
  - Correnti elettriche indotte
  - ↓ secrezione di melatonina
  - Effetti sul sistema immunitario
  - Meccanismi non noti

Modificato da Schuz J 2008

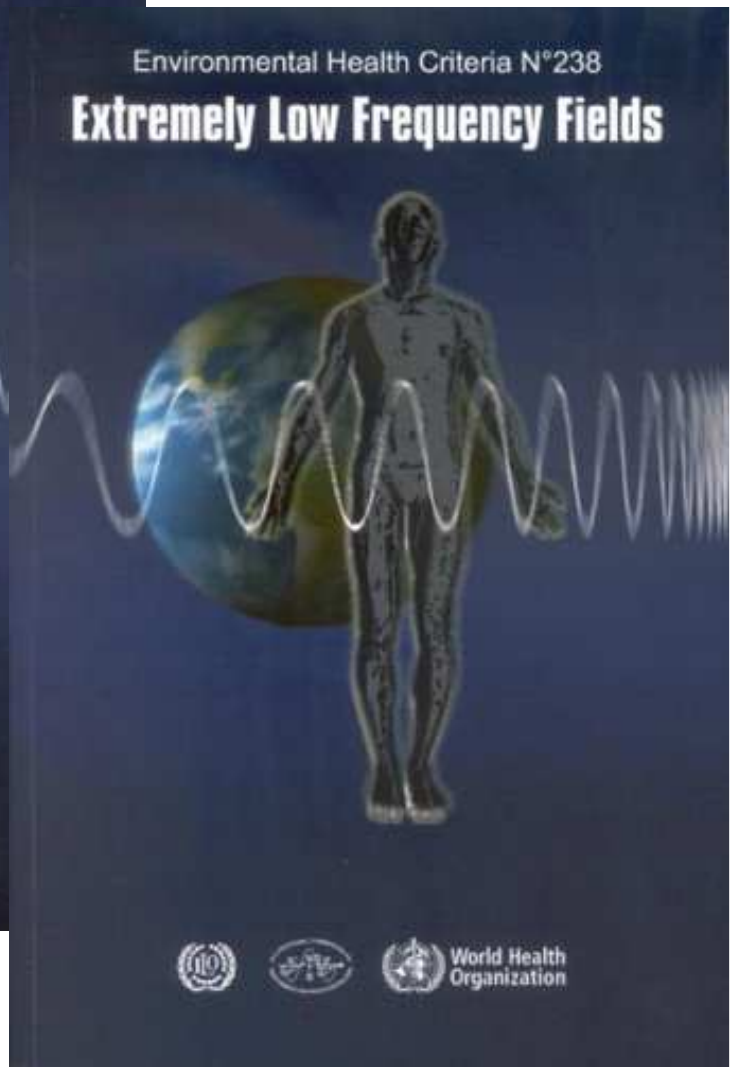
Valutazioni della IARC e del WHO



2002

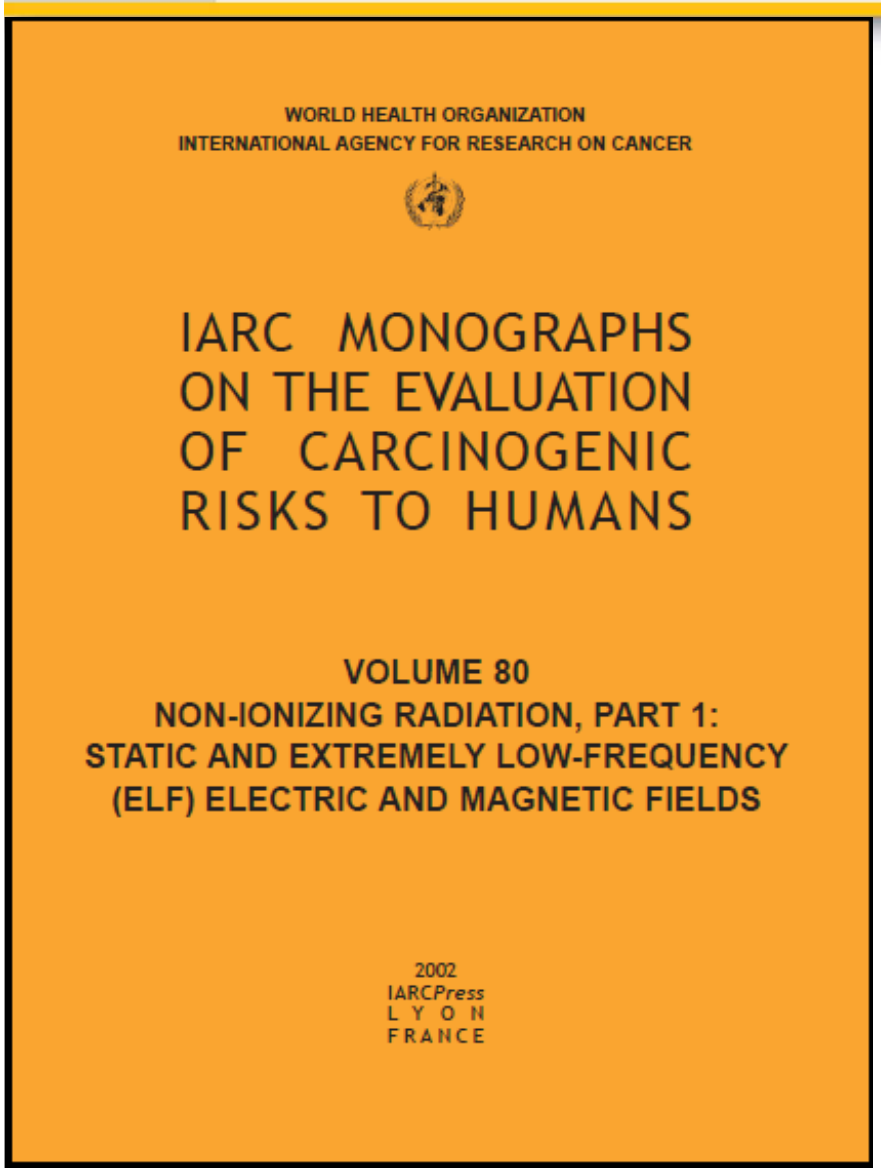


2006



2007

IARC Monograph Vol. 80 Static and Extremely Low-Frequency Electric and Magnetic Fields



Extremely low-frequency magnetic fields are ***possibly carcinogenic to humans (Group 2B).***

Static electric and magnetic fields and extremely low-frequency electric fields are *not classifiable as to their carcinogenicity to humans (Group 3)*

Valutazione della IARC

Monografia IARC del 2002: campi magnetici ELF classificati come possibilmente cancerogeni per l'uomo (Gruppo 2B) per:

- Limitata evidenza di cancerogenicità in relazione alla leucemia infantile
- Evidenza inadeguata per tutti gli altri tumori
- Evidenza inadeguata di cancerogenicità negli studi sperimentali

WHO 2007: i nuovi studi sull'uomo, su animali e *in vitro*, pubblicati dopo la monografia IARC del 2002 confermano la classificazione IARC

ELF ed effetti sulla salute

Outcome	Strength of evidence
Cancer outcomes	
Leukaemia in children	Limited
Brain tumours in children	Inadequate
Brain tumours in adults	Inadequate
Breast cancer in adults	Lack of effect
Other cancer (children or adults)	Inadequate
Neurodegenerative diseases	
Alzheimer's disease	Inadequate
Amyotrophic lateral sclerosis (ALS)	Inadequate
Other neurodegenerative diseases	Inadequate
Reproductive outcomes	
All outcomes	Inadequate
Cardiovascular diseases	
All diseases	Lack of effect
Well-being	
Electrical hypersensitivity (EHS)	Lack of effect
Symptoms	Inadequate

Fonte: European Health Risk Assessment Network on Electromagnetic Fields Exposure, 2010
http://efhran.polimi.it

Stima dell'esposizione della popolazione a campi ELF

La media geometrica del campo magnetico nelle abitazioni è tra 0.025 e 0.07 μT in Europa e tra 0.05 e 0.11 negli USA

Proporzione di esposti tra i bambini:
>0.3 μT: 1-4 %
>0.4 μT: 1-2%

Tasso di incidenza di leucemia infantile è pari a circa 80 casi per milione nei primi 3 anni di vita e a 20 casi per milione tra gli 8 e i 10 anni; In Italia sono diagnosticati circa 450 casi di leucemia infantile ogni anno.

WHO, Environmental Health Criteria 2007

Stima del rischio attribuibile a ELF

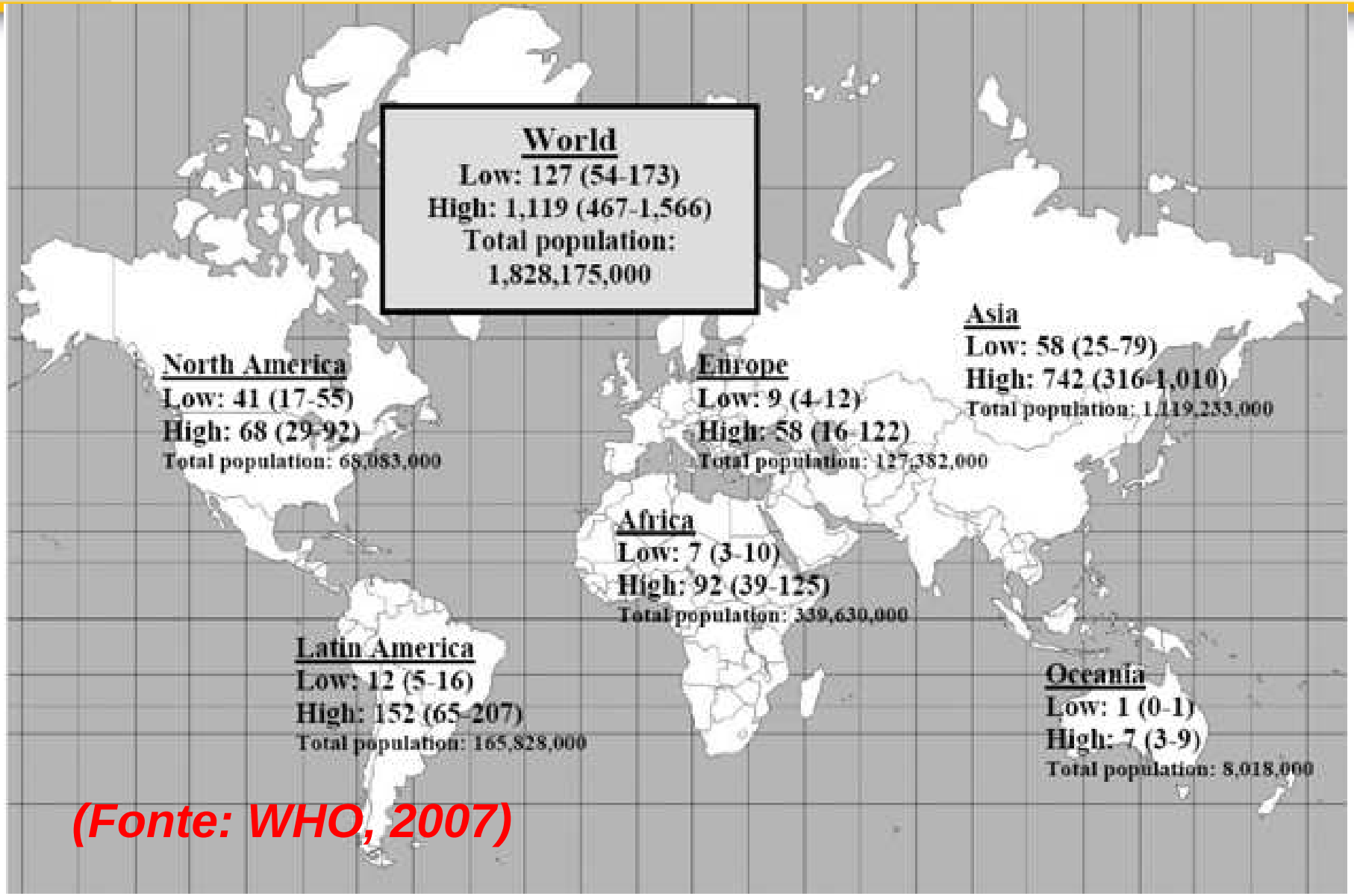
Assumendo che l'associazione tra campi ELF e leucemia infantile è causale:

il numero di casi a livello mondiale attribuibile è compreso tra 100 e 2400 casi/anno

Questo rappresenta lo **0.2-4.9%** dell'incidenza totale annuale dei casi di leucemia (impatto limitato e incerto)

(Fonte: WHO, 2007)

Stima dei casi di leucemia infantile attribuibili ai campi ELF



(Fonte: WHO, 2007)

La legislazione sui campi elettrici e magnetici a frequenza estremamente bassa (ELF)

La legislazione su ELF

Azioni dell' UE

Raccomandazione 1999/519/CE del Consiglio, del 12 luglio 1999, relativa alla limitazione dell'esposizione della popolazione ai campi elettromagnetici da 0 Hz a 300 GHz.

In Italia i valori limite sono stati definiti nel **DPCM 08/07/03** (relativi a campi elettrici e magnetici a frequenze di 50 Hz generati dagli elettrodotti)

Limite di esposizione	100μT ;
Valore di attenzione in aree con permanenza ≥4 ore/giorno	10 μT
Obiettivo di qualità per progettazione nuovi elettrodotti o aree destinate con permanenza ≥4 ore/giorno in prossimità di elettrodotti	3 μT

La legislazione su ELF

Standard internazionali (International Commission on non-ionizing radiation protection-**ICNIRP 2010**) basati sugli effetti biologici acuti degli ELF

Limite di esposizione per la popolazione

Campi elettrici =5 kV/m (a 50 Hz)

Campi magnetici=200 μT (a 50 Hz)

Limite di esposizione per i lavoratori

Campi elettrici =10 kV/m (a 50 Hz)

Campi magnetici=1 mT (a 50 Hz)

Decreto legislativo 9 aprile 2008, n. 81

Attuazione dell'articolo 1 della legge 3 agosto 2007, n. 123,

in materia di tutela della salute e della sicurezza nei luoghi di lavoro

Gazzetta Ufficiale n. 101 del 30-4-2008

Titolo VIII

AGENTI FISICI

Capo IV

Protezione dei lavoratori dai rischi di esposizione a campi elettromagnetici

Valori limite di esposizione basati sulle linee guida ICNIRP

RADIOFREQUENZE
e rischi per la salute

In italia è stimato un numero di antenne, tralicci e ripetitori di onde elettromagnetiche in numero superiore a quelli presenti negli Stati Uniti:

Oltre a 60 mila antenne trasmittenti che irradiano programmi radio e televisivi (12 mila presenti negli USA)

Wi-Fi e rischi per la salute?

Dipartimento di Epidemiologia ASL RME

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FEATURE FOCUS

Warning on wi-fi health risk to children

By Nic Fleming, Medical Correspondent
Last Updated: 10:51PM BST 19/04/2008 | Comments 52 | Have Your Say

- **Have your say: Are you concerned about living near power lines?**
- **Audio: Nic Fleming on the science behind electrosmog**

Children should not place computers on their laps while they are using wireless internet connections because of potential health risks, according to a leading Government adviser.

Professor Lawrie Challis, who heads the committee on mobile phone safety research, called yesterday for pupils to be monitored amid mounting public concern over emissions from wi-fi networks.

He is concerned that few studies have been carried out into the level of exposure in classrooms and believes that if health problems do emerge they are likely to be more serious in children.

Prof Challis, is chairman of the Mobile Telecommunications and Health Research Programme, an £8.4 million investigation, funded by the Government and the industry, into the potential health risks of mobile phones.

He said that until more research had been carried out, children who used wi-fi enabled laptops should only do so if they kept a safe distance from their embedded antennas.

According to estimates, half of all primary schools are already using wireless networks

Prof Challis said: "With a desktop computer, the transmitter will be in the tower.

Article continues

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Fact sheet N°296
December 2005

Electromagnetic fields and public health

Electromagnetic Hypersensitivity

As societies industrialize and the technological revolution continues, there has been an unprecedented increase in the number and diversity of electromagnetic field (EMF) sources. These sources include video display units (VDUs) associated with computers, mobile phones and their base stations. While these devices have made our life richer, safer and easier, they have been accompanied by concerns about possible health risks due to their EMF emissions.

For some time a number of individuals have reported a variety of health problems that they relate to exposure to EMF. While some individuals report mild symptoms and react by avoiding the fields as best they can, others are so severely affected that they cease work and change their entire lifestyle. This reputed sensitivity to EMF has been generally termed "electromagnetic hypersensitivity" or EHS.

This fact sheet describes what is known about the condition and provides information for helping people with such symptoms. Information provided is based on a WHO Workshop on Electrical Hypersensitivity (Prague, Czech Republic, 2004), an international conference on EMF and non-specific health symptoms (COST244bis, 1998), a European Commission report (Bergqvist and Vogel, 1997) and recent reviews of the literature.

WHAT IS EHS?

EHS is characterized by a variety of non-specific symptoms, which afflicted individuals attribute to exposure to EMF. The symptoms most commonly experienced include dermatological symptoms (redness, tingling, and burning sensations) as well as neurasthenic and vegetative symptoms (fatigue, tiredness, concentration difficulties, dizziness, nausea, heart palpitation, and digestive disturbances). The collection of symptoms is not part of any recognized syndrome.

EHS resembles multiple chemical sensitivities (MCS), another disorder associated with low-level environmental exposures to chemicals. Both EHS and MCS are characterized by a range of non-specific symptoms that lack apparent toxicological or physiological basis or independent verification. A more general term for sensitivity to environmental factors is Idiopathic Environmental Intolerance (IEI), which originated from a workshop convened by the International Program on Chemical Safety (IPCS) of the WHO in 1996 in Berlin. IEI is a descriptor without any implication of chemical etiology, immunological sensitivity or EMF susceptibility. IEI incorporates a number of disorders sharing similar non-specific medically unexplained symptoms that adversely affect people. However since the term EHS is in common usage it will continue to be used here.

PREVALENCE

There is a very wide range of estimates of the prevalence of EHS in the general population. A survey of occupational medical centres estimated the prevalence of EHS to be a few individuals per million in the population. However, a survey of self-help groups yielded much higher estimates. Approximately 10% of reported cases of EHS were considered severe.

There is also considerable geographical variability in prevalence of EHS and in the reported symptoms. The reported incidence of EHS has been higher in Sweden, Germany, and Denmark, than in the United Kingdom, Austria, and France. VDU-related symptoms were more prevalent in Scandinavian countries, and they were more commonly related to skin disorders than elsewhere in

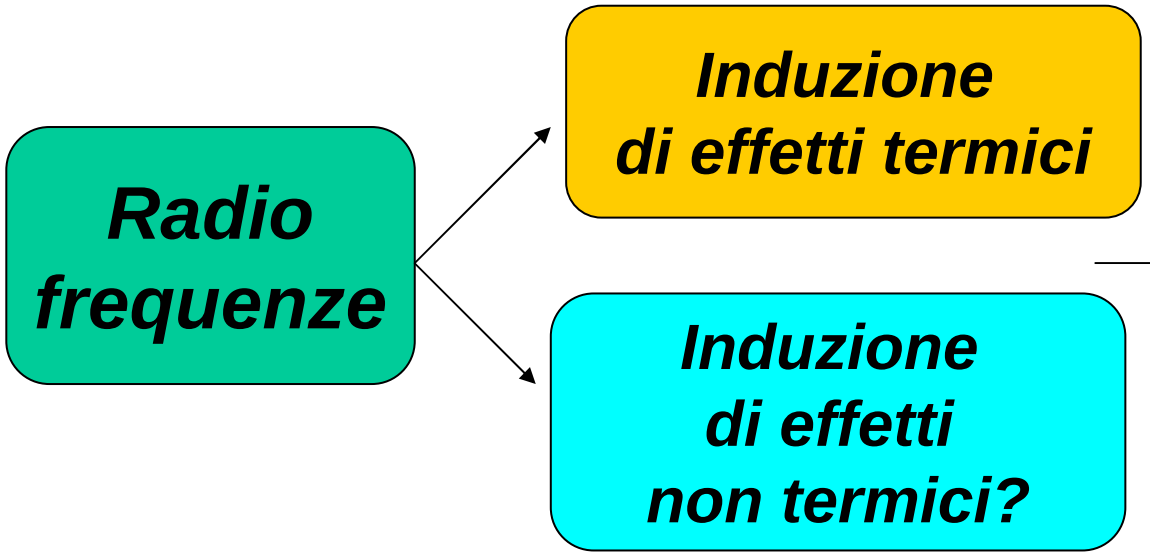
Fonti di esposizione dirette sul corpo umano	**Livelli di esposizione**
Telefoni cellulari (circa 80% della popolazione mondiale è esposta)	250 mW max trasmessa da GSM a 900 MHz
Altre applicazioni wireless (es. telefoni cordless, sistemi WLAN, DECT)	max 200 mW
Fonti di esposizione lontane dal corpo umano	
Stazioni radio base telefonia cellulare	100 nW/m^2 - 10 mW/m^2
Sistemi di trasmissione radio (AM, FM) e TV	circa 300 mW/m^2


Uso di telefoni
cellulari
e tumori cerebrali
iPhoneWorld.ca

I livelli di esposizione a Radiofrequenze in Italia

- L'Italia è il terzo Paese al mondo per diffusione di telefonini dopo Stati Uniti e Giappone, con circa 35 milioni di utenti; si stima che in breve sarà raggiunto il record dei 40 milioni di abbonati; in Italia il numero di utenze di telefonia mobile per abitante è attualmente pari **al 160%.**

Meccanismi biologici delle RF



Effetti genotossici (es. aberrazioni cromosomiche)

Effetti epigenetici (es.esposizione a RF in utero)

Effetto combinato con agenti fisici e chimici

Evidenza inadeguata sugli effetti cronici, in particolare a valori bassi di SAR (<2 W/kg)

Possibili effetti genotossici delle RF

RADIATION RESEARCH **169**, 28–37 (2008)
0033-7587/08 $15.00

Increased Levels of Numerical Chromosome Aberrations after *In Vitro* Exposure of Human Peripheral Blood Lymphocytes to Radiofrequency Electromagnetic Fields for 72 Hours

Ronit Mazor,[a,1] Avital Korenstein-Ilan,[a,1] Alexander Barbul,[a] Yael Eshet,[b] Avi Shahadi,[b] Eli Jerby[b] and Rafi Korenstein[a,2]

We investigated the effects of 72 h *in vitro* exposure of 10 human lymphocyte samples to radiofrequency electromagnetic fields (800 MHz, continuous wave) on genomic instability. The lymphyocytes were exposed in a specially designed waveguide resonator at specific absorption rates (SARs) of 2.9 and 4.1 W/kg in a temperature range of 36–37°C. The induced aneuploidy of chromosomes 1, 10, 11 and 17 was determined by interphase FISH using semi-automated image analysis. We observed increased levels of aneuploidy depending on the chromosome studied as well as on the level of exposure. In chromosomes 1 and 10, there was increased aneuploidy at the higher SAR, while for chromosomes 11 and 17, the increases were observed only for the lower SAR. Multisomy (chromosomal gains) appeared to be the primary contributor to the increased aneuploidy. The effect of temperature on the level of aneuploidy was examined over the range of 33.5–40°C for 72 h with no statistically significant difference in the level of aneuploidy compared to 37°C. These findings suggest the possible existence of an athermal effect of RF radiation that causes increased levels of aneuploidy. These results contribute to the assessment of potential health risks after continuous chronic exposure to RF radiation at SARs close to the current levels set by ICNIRP guidelines. © 2008 by Radiation Research Society

Possibili effetti epigenetici delle RF

Aldad TS ***Fetal Radiofrequency Radiation Exposure From 800-1900 Mhz-Rated Cellular Telephones Affects Neurodevelopment and Behavior in Mice***
Nature Scientific Reports Volume: 2, Article number: 312 doi:10.1038/srep00312

Here we demonstrate that fetal exposure to 800–1900 Mhz-rated radiofrequency radiation from cellular telephones leads to behavioral and neurophysiological alterations that persist into adulthood.
Mice exposed during pregnancy had impaired memory, were hyperactive, and had decreased anxiety, indicating that *in-utero* exposure to radiofrequency is a potential cause of neurobehavioral disorders.
We further demonstrated impairment of glutamatergic synaptic transmission onto pyramidal cells in the prefrontal cortex associated with these behavioral changes, suggesting a mechanism by which *in-utero* cellular telephone radiation exposure may lead to the increased prevalence of neurobehavioral disorders.

Effetti biologici delle RF

Outcome	Strength of evidence
Cancer studies	
- Genotoxic effects	
In vitro	Limited evidence
In vivo	Lack of effect
- Non genotoxic effects	
In vitro	Inadequate evidence
In vivo	Inadequate evidence
Nervous system	
- BBB	Lack of effect
- Stress response	Limited evidence
- Gene expression	Inadequate evidence
- Neurodegenerative disease	Inadequate evidence
- Neurogenesis	Inadequate evidence
- Behaviour	Inadequate evidence
- *In vitro*	Limited evidence
Development and reproduction	
- Development, teratology	Inadequate evidence
- Reproduction	Inadequate evidence
- *In vitro*	Inadequate evidence
Miscellaneous	
- Auditory	Lack of effect
- Immunology	
In vivo	Inadequate evidence
In vitro	Inadequate evidence

Fonte: European Health Risk Assessment Network on Electromagnetic Fields Exposure, 2010
http://efhran.polimi.it

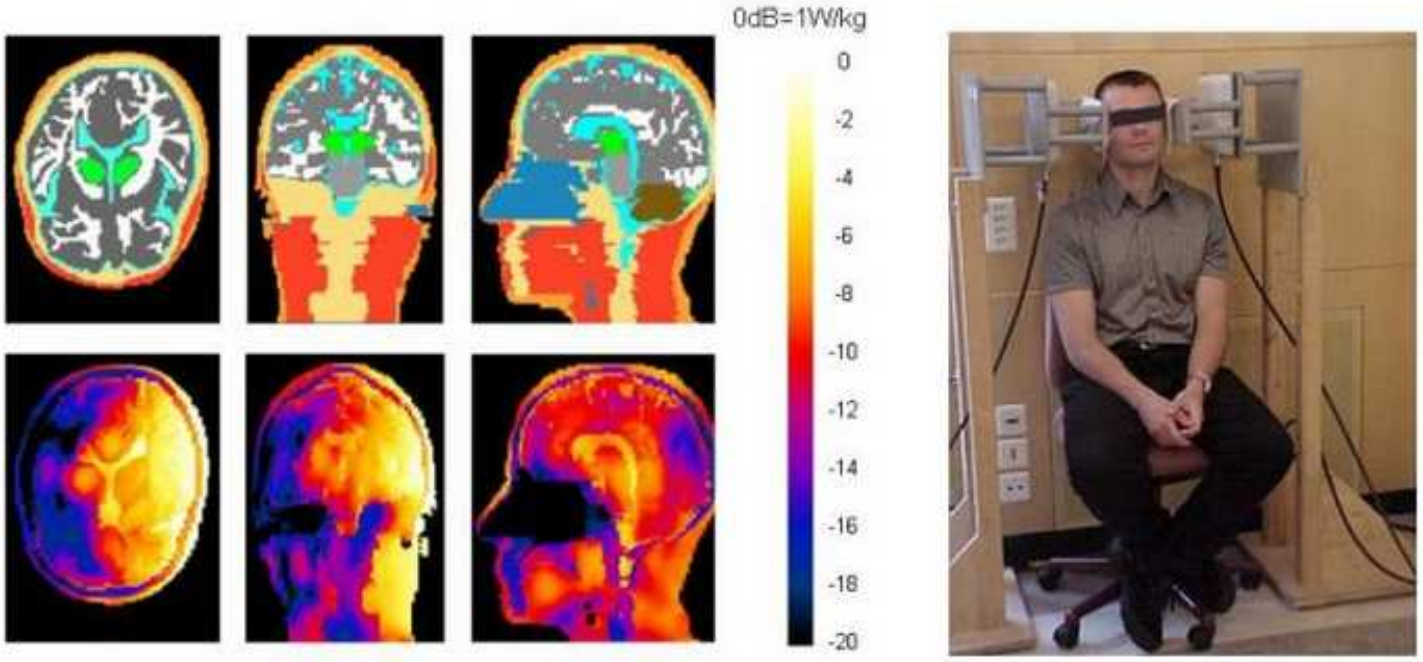
Tasso di assorbimento specifico **(SAR)**

Le RF interagiscono con gli organismi viventi principalmente cedendo energia che viene trasformata in calore. Questo rilascio d'energia viene descritto in termini di tasso di assorbimento specifico o SAR (acronimo delle parole inglesi Specific Absorption Rate), che è la potenza assorbita per unità di massa di tessuto irradiato (espresso in watt a chilogrammo, W/kg) e che può essere riferito all'intero corpo o organo (SAR medio) o a una piccola regione specifica all'interno del corpo (SAR localizzato).

Tasso di assorbimento specifico **(SAR)**

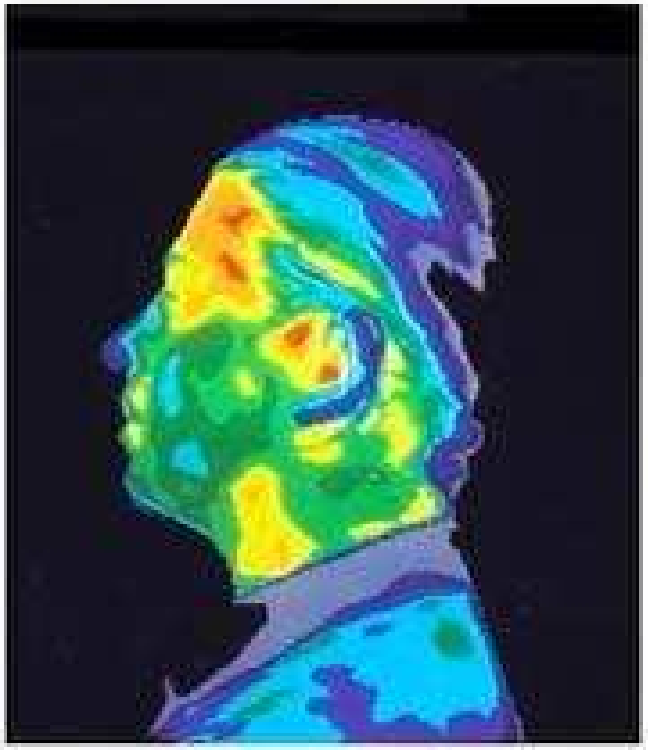
The ***Specific Absorption Rate (SAR)*** is a measure of the amount of radio frequency energy absorbed by the body. International limits for local exposures, i.e., peak spatial SAR averaged over any 10 g of tissue, are 2 W/kg for the general public and 10 W/kg for occupational exposure (ICNIRP, 1998).

A typical exposure setup as used in our studies is illustrated in Fig. 2 (right) and the distribution of the SAR when exposing the right hemisphere (right antenna activated) is depicted on the left.

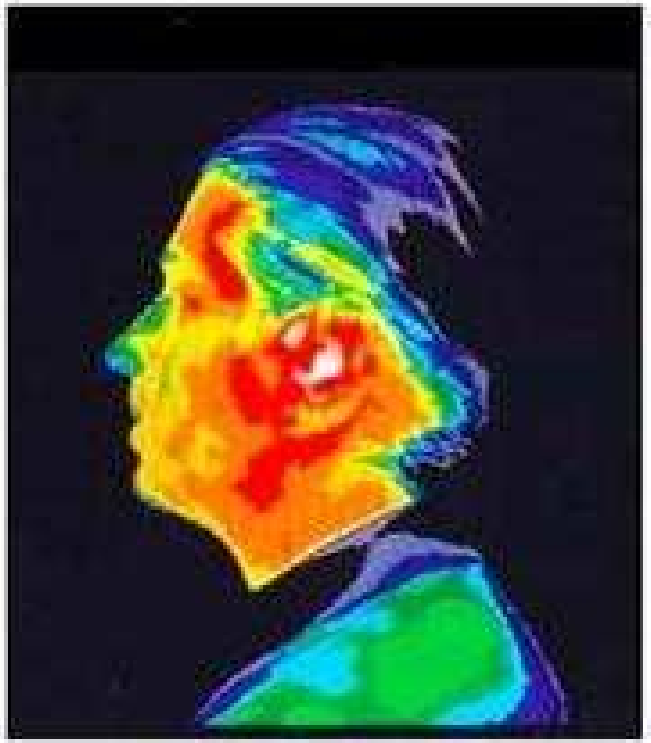


Left: Computed distribution of the specific absorption rate (SAR) for the tissue model shown in the top row (right antenna activated): thalamus (green), grey matter (dark grey), white matter (white), CSF (cyan), cerebellum (brown), middle brain (light gray), muscle (dark orange), air (blue), skin (orange) and bone (yellow). Right: Typical exposure setup. Subject sitting on a chair, head positioned between two plates to ensure a well-defined head position. Antennas were mounted on both sides of the head. References

ICNIRP (1998). Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). Health Physics 74: 494-522.

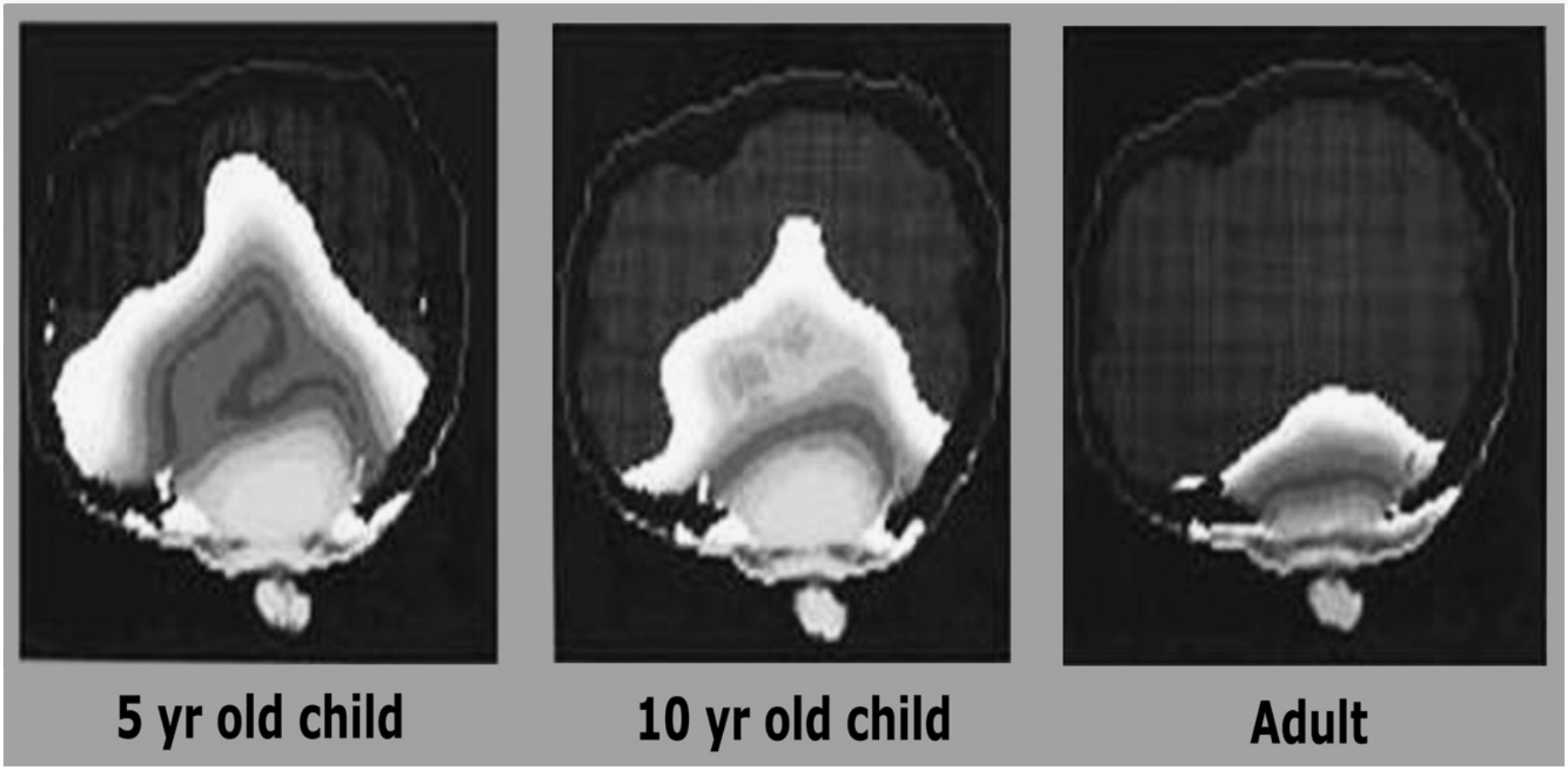


Thermographic Image of the head with no exposure to harmful cell phone radiation.



Thermographic Image of the head after a 15-minute phone call. Yellow and red areas indicate thermal (heating) effects that can cause negative health effects.

Assorbimento delle radiofrequenze da telefoni cellulari nel cervello umano in relazione all'età



Cell phone signal is absorbed deeply into the brains of children

Dubey 2010, http://www.environmentalhealthtrust.org

Lo studio Interphone

Lo studio Interphone è uno studio epidemiologico di tipo caso-controllo durato oltre 10 anni, i cui risultati sono stati pubblicati nel 2010.

Il gruppo di studio è composto da 21 ricercatori di 13 paesi (la Dr. Elisabeth Cardis della IARC è coordinatrice dello studio)

Fino ad oggi, il finanziamento complessivo assegnato allo studio Interphone ammonta a circa 19,2 milioni di euro, di cui 5.5 milioni di euro sono stati versati da fonti industriali.

Studio INTERPHONE

Studi caso-controllo in 13 paesi (protocollo comune)
2708 casi di glioma, 2409 casi di meningioma, 1121 casi di tumore del nervo acustico - diagnosi tra il 2000 e il 2004 - età 30-59 anni alla diagnosi - 1 controllo per ogni caso
Utilizzo del telefono cellulare: - durata breve, media e lunga (data di inizio: 1-4, 5-9, ≥10 anni precedenti) - intensità (ore cumulate di utilizzo)

Lo studio internazionale INTERPHONE

Published by Oxford University Press on behalf of the International Epidemiological Association
International Journal of Epidemiology 2010;39:675–694
doi:10.1093/ije/dyq079

THEME: CANCER

Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case–control study

The INTERPHONE Study Group*

A reduced odds ratio (OR) related to ever having been a regular mobile phone user was seen for glioma [OR 0.81; 95% confidence interval (CI) 0.70–0.94] and meningioma (OR 0.79; 95% CI 0.68–0.91), possibly reflecting participation bias or other methodological limitations. No elevated OR was observed ⩾10 years after first phone use (glioma: OR 0.98; 95% CI 0.76–1.26; meningioma: OR 0.83; 95% CI 0.61–1.14). ORs were <1.0 for all deciles of lifetime number of phone calls and nine deciles of cumulative call time. In the 10th decile of recalled cumulative call time, ⩾1640 h, the OR was 1.40 (95% CI 1.03–1.89) for glioma, and 1.15 (95% CI 0.81–1.62) for meningioma; but there are implausible values of reported use in this group. ORs for glioma tended to be greater in the temporal lobe than in other lobes of the brain, but the CIs around the lobe-specific estimates were wide. ORs for glioma tended to be greater in subjects who reported usual phone use on the same side of the head as their tumour than on the opposite side.

Lo studio internazionale INTERPHONE

IARC Report to the Union for International Cancer Control (UICC) on the Interphone Study

Dr Christopher Wild, Director
Lyon, 03 October 2011

Introduction

Mobile phone use has increased dramatically in many countries since its introduction in the early-to-mid 1980s. The expanding use of this technology has been accompanied by concerns about health and safety. In the late 1990s, several expert groups critically reviewed the evidence on health effects of low-level exposure to radiofrequency (RF) electromagnetic fields emitted by mobile phones, and recommended research into the possible adverse health effects of mobile telephone use. As a result, the International Agency for Research on Cancer (IARC) coordinated a feasibility study in 1998 and 1999, which concluded that an international study of the relationship between mobile phone use and brain tumour risk would be feasible and informative.

Interphone was therefore initiated as an international set of case–control studies[1] focussing on four types of tumours in tissues that most absorb RF energy emitted by mobile phones: tumours of the brain (glioma and meningioma), acoustic nerve (schwannoma) and parotid gland. The objective was to determine whether mobile phone use increases the risk of these tumours and, specifically, whether RF energy emitted by mobile phones is carcinogenic. The methods, results and conclusions are provided here and thus this report to the UICC marks the completion of the Interphone Study.

Il Dr. Christopher Wild, Direttore della IARC, ha dichiarato:

"Un aumento del rischio di tumori cerebrali non è documentato dai dati di Interphone. Tuttavia, le osservazioni ai livelli più alti del tempo complessivo di conversazione, e i cambiamenti intervenuti nel profilo d'uso successivamente al periodo studiato da Interphone, soprattutto da parte dei giovani, implicano l'opportunità di ulteriori indagini su uso del telefono cellulare e tumori cerebrali."

Gli studi caso-controllo svedesi (Hardell 2011)

INTERNATIONAL JOURNAL OF ONCOLOGY 38: 1465-1474, 2011

Pooled analysis of case-control studies on malignant brain tumours and the use of mobile and cordless phones including living and deceased subjects

LENNART HARDELL[1], MICHAEL CARLBERG[1] and KJELL HANSSON MILD[2]

(85%) cases and 2,438 (84%) controls. The risk increased with latency period and cumulative use in hours for both mobile and cordless phones. Highest risk was found for the most common type of glioma, astrocytoma, yielding in the >10 year latency group for mobile phone use odds ratio (OR) = 2.7, 95% confidence interval (CI) = 1.9-3.7 and cordless phone use OR = 1.8, 95% CI = 1.2-2.9. In a separate analysis, these phone types were independent risk factors for glioma. The risk for astrocytoma was highest in the group with first use of a wireless phone before the age of 20; mobile phone use OR = 4.9, 95% CI = 2.2-11, cordless phone use OR = 3.9, 95% CI = 1.7-8.7. In conclusion, an increased risk was found for glioma and use of mobile or cordless phone. The risk increased with latency time and cumulative use in hours and was highest in subjects with first use before the age of 20.

Lo studio di coorte Danese (Frei 2011)

Use of mobile phones and risk of brain tumours: update of Danish cohort study

OPEN ACCESS

Patrizia Frei *postdoctoral research fellow*[1], Aslak H Poulsen *doctoral student*[1], Christoffer Johansen *professor*[1], Jørgen H Olsen *director*[1], Marianne Steding-Jessen *statistician*[1], Joachim Schüz *head of section*[2]

Results 358 403 subscription holders accrued 3.8 million person years. In the follow-up period 1990-2007, there were 10 729 cases of tumours of the central nervous system. The risk of such tumours was close to unity for both men and women. When restricted to individuals with the longest mobile phone use—that is, ≥13 years of subscription—the incidence rate ratio was 1.03 (95% confidence interval 0.83 to 1.27) in men and 0.91 (0.41 to 2.04) in women. Among those with subscriptions of ≥10 years, ratios were 1.04 (0.85 to 1.26) in men and 1.04 (0.56 to 1.95) in women for glioma and 0.90 (0.57 to 1.42) in men and 0.93 (0.46 to 1.87) in women for meningioma. There was no indication of dose-response relation either by years since first subscription for a mobile phone or by anatomical location of the tumour—that is, in regions of the brain closest to where the handset is usually held to the head.

RESEARCH Open Access

Mobile phones and head tumours. The discrepancies in cause-effect relationships in the epidemiological studies - how do they arise?

Angelo G Levis[1], Nadia Minicuci[2], Paolo Ricci[3], Valerio Gennaro[4] and Spiridione Garbisa[1*]

Abstract

Background: Whether or not there is a relationship between use of mobile phones (analogue and digital cellulars, and cordless) and head tumour risk (brain tumours, acoustic neuromas, and salivary gland tumours) is still a matter of debate; progress requires a critical analysis of the methodological elements necessary for an impartial evaluation of contradictory studies.

Methods: A close examination of the protocols and results from all case-control and cohort studies, pooled- and meta-analyses on head tumour risk for mobile phone users was carried out, and for each study the elements necessary for evaluating its reliability were identified. In addition, new meta-analyses of the literature data were undertaken. These were limited to subjects with mobile phone latency time compatible with the progression of the examined tumours, and with analysis of the laterality of head tumour localisation corresponding to the habitual laterality of mobile phone use.

Results: Blind protocols, free from errors, bias, and financial conditioning factors, give positive results that reveal a

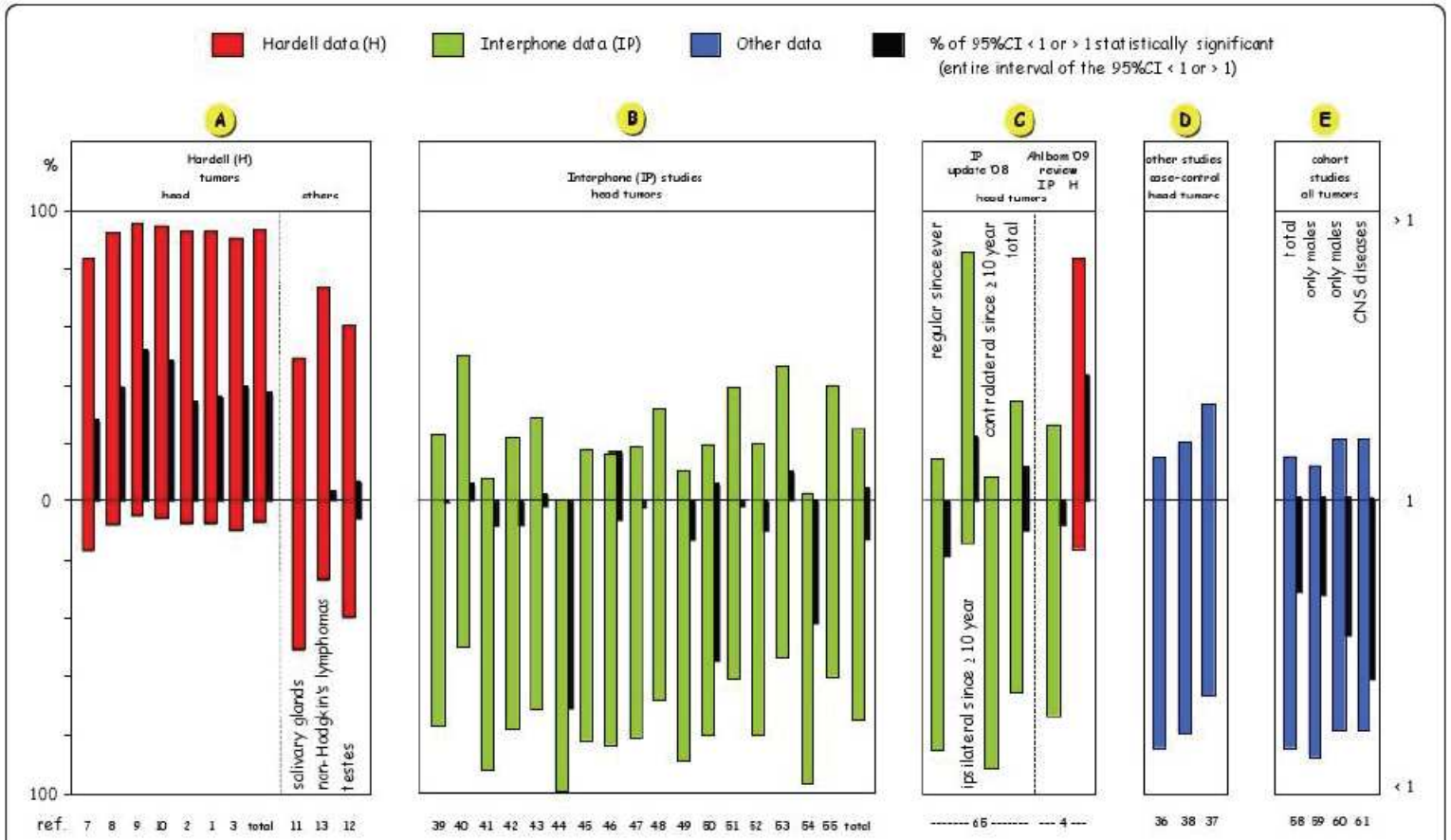


Figure 1 Hardell and Interphone data: percentage of the OR values > 1 or < 1, and percentage of those statistically significant.

Table 4 Errors in negative Interphone studies [4,36-55,65,72], and reliability of positive Hardell studies [1-3,7-10,64,71,78]

study, design, methods	negative studies	positive studies
Mobile phone use	inadequate: 2-5 min/day	significant: 16-32 min/day
Latency time	<5% cases with latency ≥10 y	>18% cases with latency ≥10 y
Cordless phone users	considered unexposed	considered exposed
Ipsilateral tumour latency	≥10 y for only 2% cases	≥10 y for >16% cases
Head tumours identified	only gliomas, meningiomas, neuromas, parotid tumours	also other head tumours types
Deceased cases	not included	included: proxy interviews
Interviews	not blind	always double blind
Type of interviews	face-to-face	mailed questionnaires
Time of interviews	cases: during hospitalisation	cases: after hospitalisation
	controls: at home	controls: at home
Exposure assessment	non blind interview	blind questionnaire
Data processing	not stated (not blind?)	Blind
Laterality attribution bias	present	Absent
Delayed interviews	for controls compared to cases	not delayed
Participation	reduced up to 40%	always near to 90%
Selection	exposed controls prevail	no selection bias
Documentation	positive data ignored	no documentation bias
Funding	co-funded by MP Companies	funded only by Public Bodies

Personal exposure to RF-EMF: mobile telephone use

Three types of study addressed the question of cancer risk and mobile-phone use

- **Ecological studies on time trends of disease rates.**

  These analyses covered the period of the late 1990s and early 2000s, i.e. before mobile phone use became widespread.

- **Cohort study**

  A total of 257 cases of glioma were found in 420,095 subscribers to two Danish telephone companies, with 253.9 expected. Having a subscription was taken as a surrogate for phone use. The study suffers from exposure misclassification.

- **Case-control studies:** Overall, these studies provide the strongest evidence to date.

Case-control studies on mobile phone use

Muscat *et al* (2000), Inskip *et al* (2001), and Auvinen *et al* (2002) published early studies in the period of increasing use, with exposure assessment by self-reported history or by subscription records, and imprecise effect estimates.

	Phone type	Odds ratio (95%CI)	(from: Auvinen *et al*, 2002)
Glioma	all phones	1.5 (1.0–2.4)	
(n=398)	digital phones	1.0 (0.5–2.0)	
	analog phones	2.1 (1.3–3.4)	(analog wireless phones emit more RF-energy)

INTERPHONE (Cardis *et al.*, 2010), a multicentre case-control study of mobile-phone use and brain tumours, including glioma, acoustic neuroma, and meningioma.

The pooled analysis included 2708 glioma cases and 2972 controls (2000–2004; participation rates 64% and 53%, resp.). Ever/never use of a mobile phone yielded an OR of 0.81 (0.70-0.94). Odds ratios were uniformly below or close to unity for all deciles of exposure except for the highest decile (cumulative call time, >1640 hrs): OR, 1.40 (1.03–1.89).

Studies from Sweden (pooled analysis, Hardell *et al.*, 2011)

The analysis included 1148 glioma cases (ascertained in 1997–2003) and 2438 controls obtained through cancer/population registries. Questionnaires and telephone interviews were used to obtain information on use of mobile and cordless phones (response rates 85% and 84%). Those who had used a phone for >1 year had an OR for glioma of 1.3 (95% CI 1.1–1.6), which increased with longer time since first use and with total call time, to 3.2 (2.0–5.1) for > 2000 hours of use.

Although both the INTERPHONE study and the Swedish studies are susceptible to bias, the Working Group concluded that the findings cannot be dismissed as reflecting bias alone, and that a causal interpretation is possible. A similar conclusion was drawn for acoustic neuroma, from these studies and from a Japanese study. For meningioma, parotid-gland tumours, leukaemia, lymphoma, and other cancers, the Working Group found the evidence insufficient to reach a conclusion.

The Working Group concluded: there is *limited evidence* in humans for the carcinogenicity of RF-EMF, based on positive associations between glioma and acoustic neuroma and exposure to RF-EMF from wireless telephones.

RF ed effetti sulla salute

Outcome	Strength of evidence
Cancer outcomes	
Leukaemia in children	Inadequate
Brain tumours in children	Inadequate
Brain tumours in adults	Limited
Breast cancer in adults	Inadequate
Other cancer (children or adults)	Inadequate
Neurodegenerative diseases	
Alzheimer's disease	Inadequate
Amyotrophic lateral sclerosis (ALS)	Inadequate
Other neurodegenerative diseases	Inadequate
Reproductive outcomes	
All outcomes	Inadequate
Cardiovascular diseases	
All diseases	Inadequate
Well-being	
Electrical hypersensitivity (EHS)	Lack of effect
Symptoms	Inadequate

Modificata da European Health Risk Assessment Network on Electromagnetic Fields Exposure, 2010 http://efhran.polimi.it

Conflitto di interesse negli studi sugli effetti dei telefoni cellulari?

Associazione tra fonte di finanziamento e risultati degli studi:

Review	Model	Industry	Public
2005–2009	Crude	0.33 (0.04–3.06)	1 (referent)
1995–2005	Crude	0.29 (0.05–1.59)	1 (referent)
Combined analysis	Crude	0.55 (0.17–1.77)	1 (referent)
	Adjusted for year of publication	0.20 (0.05–0.85)	1 (referent)

minore probabilità di riportare effetti sulla salute

L.E. van Nierop et al. / C. R. Physique 11 (2010) 622–627

Esposizione residenziale a radiofrequenze e rischio di leucemie infantili

Studi epidemiologici su esposizione residenziale a RF e leucemia infantile

Studio	Disegno di studio	Fonte di esposizione	Esito	Distanza	Risultati
Maskarinec 1994 *Hawaii*	Caso-controllo	Trasmettitori radio a bassa frequenza	Incidenza	0-2.6 miglia	OR=2.0 (0.06-8.3) *vs* >2.6 miglia
Hocking 1996 *Sydney (Australia)*	Ecologico	Antenna TV	Incidenza	n.d.	RR=1.58 (1.07-2.34)
			Mortalità	n.d.	RR=2.32 (1.35-4.01)
Dolk 1997a *UK*	Ecologico	TV e radio FM	Incidenza	0-2 km	SIR=1.12 (0.61-2.06)
Dolk 1997b *Sutton Coldfield (UK)*	Ecologico	TV e radio FM	Incidenza	0-2 km	29.7 casi attesi
McKenzie 1998 *Sydney (Australia)*	Ecologico	Antenna TV	Incidenza	n.d.	RR=1.38 (0.99-1.91) per $\mu W/cm^2$
Cooper 2001 *Sutton Coldfield (UK)*	Ecologico	TV e radio FM	Incidenza	0-2 km	SIR=1.13 (0.03, 6.27)
				0-10 km	SIR=1.08 (0.71, 1.59)
Michelozzi 2002 *Cesano (Italia)*	Ecologico	Stazione radio	Incidenza	0-6 km	SIR=2.2 (1.0-4.1)
Park 2004 *Corea*	Ecologico	Trasmettitori radio AM	Mortalità	n.d.	SMR=2.29 (1.05-5.98)
Ha 2007 *Corea del Sud*	Caso-controllo	Trasmettitori radio AM; Antenne radio	Incidenza	0-2 km	OR=2.15 (1.0-4.67) *vs* >20 km
Merzenich 2008 *Germania Ovest*	Caso-controllo	Trasmettitori radio/TV	Incidenza	0-2 km	OR=1.04 (0.65-1.67) *vs* 10-15 km

Gli studi epidemiologici

American Journal of Epidemiology

Vol. 166, No. 3
DOI: 10.1093/aje/kwm083
Advance Access publication June 7, 2007

Original Contribution

Radio-Frequency Radiation Exposure from AM Radio Transmitters and Childhood Leukemia and Brain Cancer

Mina Ha[1], Hyoungjune Im[2], Mihye Lee[3], Hyun Joo Kim[4], Byung-Chan Kim[5], Yoon-Myoung Gimm[6], and Jeong-Ki Pack[7]

Leukemia and brain cancer patients under age 15 years, along with controls with respiratory illnesses who were matched to cases on age, sex, and year of diagnosis (1993–1999), were selected from 14 South Korean hospitals using the South Korean Medical Insurance Data System. Diagnoses were confirmed through the South Korean National Cancer Registry. Residential addresses were obtained from medical records. A newly developed prediction program incorporating a geographic information system that was modified by the results of actual measurements was used to estimate radio-frequency radiation (RFR) exposure from 31 amplitude modulation (AM) radio transmitters with a power of 20 kW or more. A total of 1,928 leukemia patients, 956 brain cancer patients, and 3,082 controls were analyzed. Cancer risks were estimated using conditional logistic regression adjusted for residential area, socioeconomic status, and community population density. The odds ratio for all types of leukemia was 2.15 (95% confidence interval (CI): 1.00, 4.67) among children who resided within 2 km of the nearest AM radio transmitter as compared with those resided more than 20 km from it. For total RFR exposure from all transmitters, odds ratios for lymphocytic leukemia were 1.39 (95% CI: 1.04, 1.86) and 1.59 (95% CI: 1.19, 2.11) for children in the second and third quartiles, respectively, versus the lowest quartile. Brain cancer and infantile cancer were not associated with AM RFR.

Gli studi epidemiologici

American Journal of Epidemiology

Vol. 168, No. 10
DOI: 10.1093/aje/kwn230
Advance Access publication October 3, 2008

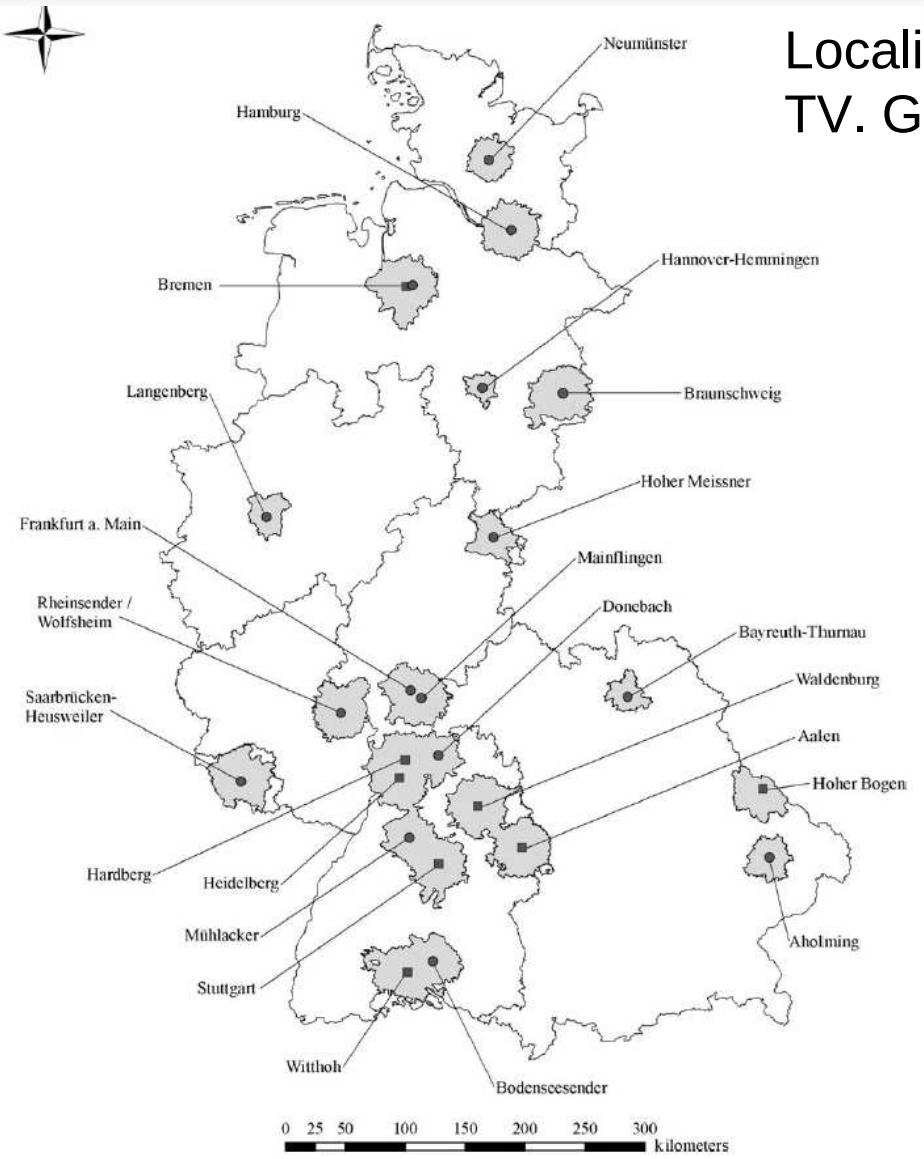
Original Contribution

Childhood Leukemia in Relation to Radio Frequency Electromagnetic Fields in the Vicinity of TV and Radio Broadcast Transmitters

Hiltrud Merzenich, Sven Schmiedel, Sabrina Bennack, Hauke Brüggemeyer, Johannes Philipp, Maria Blettner, and Joachim Schüz

A case-control study of radio frequency electromagnetic fields (RF-EMFs) and childhood leukemia was conducted in West Germany. The study region included municipalities near high-power radio and TV broadcast towers, including 16 amplitude-modulated and 8 frequency-modulated transmitters. Cases were aged 0–14 years, were diagnosed with leukemia between 1984 and 2003, and were registered at the German Childhood Cancer Registry. Three age-, gender-, and transmitter-area-matched controls per case were drawn randomly from population registries. The analysis included 1,959 cases and 5,848 controls. Individual exposure to RF-EMFs 1 year before diagnosis was estimated with a field strength prediction program. Considering total RF-EMFs, the odds ratio derived from conditional logistic regression analysis for all types of leukemia was 0.86 (95% confidence interval: 0.67, 1.11) when upper (≥95%/0.701 V/m) and lower (<90%/0.504 V/m) quantiles of the RF-EMF distribution were compared. An analysis of amplitude-modulated and frequency-modulated transmitters separately did not show increased risks of leukemia. The odds ratio for all types of leukemia was 1.04 (95% confidence interval: 0.65, 1.67) among children living within 2 km of the nearest broadcast transmitter compared with those living at a distance of 10–<15 km. The data did not show any elevated risks of childhood leukemia associated with RF-EMFs.

Gli studi epidemiologici



Localizzazione dei 24 trasmettitori radio e TV. Germania, 1984-2003.

Merzenich et al. Am J Epidemiol 2008

Gli studi epidemiologici

Rischi di leucemia infantile in base alla distanza da trasmettitori radio e TV. Germania 1984-2003.
Modificato da Merzenich et al. Am J Epidemiol 2008

Distance, km[a]	All Cases			
	No. of Controls	No. of Cases	OR	95% CI
AM or FM/TV transmitter				
0–<2	67	25	1.04	0.65, 1.67
2–<6	587	172	0.81	0.66, 0.99
6–<10	1,096	314	0.79	0.67, 0.93
10–<15	1,549	551	1.00	Reference
≥15	2,457	866	1.00	0.88, 1.14

Stazioni radio-base di telefonia cellulare

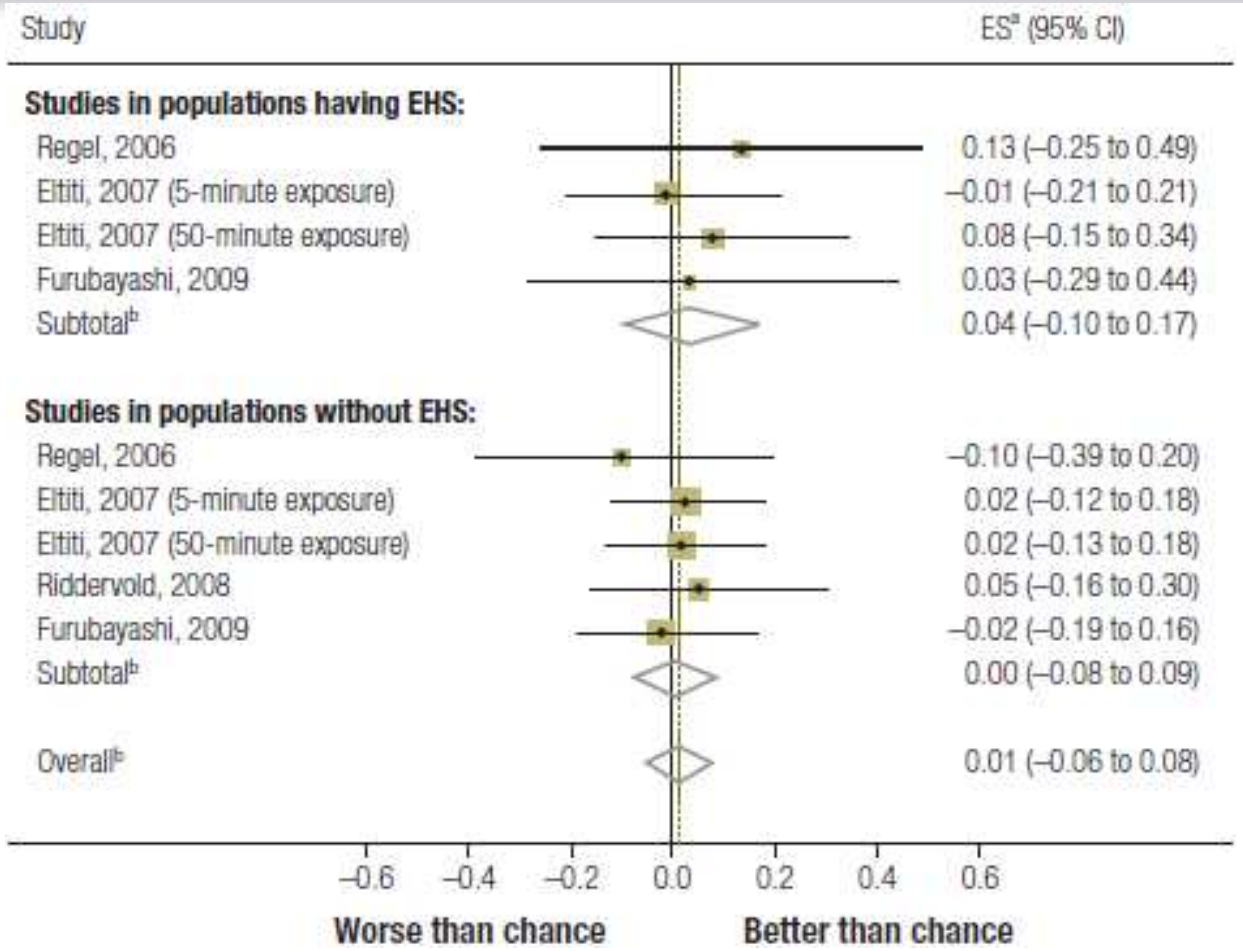
Systematic review on the health effects of exposure to radiofrequency electromagnetic fields from mobile phone base stations

Martin Röösli,[a] Patrizia Frei,[a] Evelyn Mohler[a] & Kerstin Hug[a]

Objective To review and evaluate the recent literature on the health effects of exposure to mobile phone base station (MPBS) radiation.
Methods We performed a systematic review of randomized human trials conducted in laboratory settings and of epidemiological studies that investigated the health effects of MPBS radiation in the everyday environment.
Findings We included in the analysis 17 articles that met our basic quality criteria: 5 randomized human laboratory trials and 12 epidemiological studies. The majority of the papers (14) examined self-reported non-specific symptoms of ill-health. Most of the randomized trials did not detect any association between MPBS radiation and the development of acute symptoms during or shortly after exposure. The sporadically observed associations did not show a consistent pattern with regard to symptoms or types of exposure. We also found that the more sophisticated the exposure assessment, the less likely it was that an effect would be reported. Studies on health effects other than non-specific symptoms and studies on MPBS exposure in children were scarce.
Conclusion The evidence for a missing relationship between MPBS exposure up to 10 volts per metre and acute symptom development can be considered strong because it is based on randomized, blinded human laboratory trials. At present, there is insufficient data to draw firm conclusions about health effects from long-term low-level exposure typically occurring in the everyday environment.

Bull World Health Organ 2010;88:887–896G | doi:10.2471/BLT.09.071852

Mobile phone base stations and **acute symptoms**



Most of the randomized trials did not detect any association between **mobile phone base stations radiation** and the development of **acute symptoms** during or shortly after exposure.

EHS, electromagnetic hypersensitivity

IARC Monograph Vol. 102 Radiofrequency Electromagnetic Fields (*in stampa*)

International Agency for Research on Cancer

World Health Organization

PRESS RELEASE
N° 208

31 May 2011

IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS

Lyon, France, May 31, 2011 -- The WHO/International Agency for Research on Cancer (IARC) has classified radiofrequency electromagnetic fields as **possibly carcinogenic to humans (Group 2B)**, based on an increased risk for **glioma**, a malignant type of brain cancer[1], associated with wireless phone use.

Radiofrequency Electromagnetic Fields: evaluation of cancer hazards

Robert Baan, Yann Grosse, Béatrice Lauby-Secretan, Fatiha El Ghissassi, Véronique Bouvard, Lamia Benbrahim-Tallaa, Neela Guha, Farhad Islami, Laurent Galichet, Kurt Straif, on behalf of the WHO International Agency for Research on Cancer Monograph Working Group

IARC Monographs on physical agents

Monograph Volume 75 (2000)
Ionizing Radiation, Part I: X- and Gamma (γ)-Radiation, and Neutrons
Monograph Volume 78 (2001)
Ionizing Radiation, Part II: Some Internally Deposited Radionuclides
Monograph Volume 80 (2002)
Non-ionizing Radiation, Part I: Static and Extremely Low-Frequency (ELF) Electromagnetic Fiel
Monograph Volume 102 (2011)
Non-ionizing Radiation, Part II, Radiofrequency Electromagnetic Fields (RF-EMF)

IARC Monograph on RF-EMF

In May 2011, an *IARC Monographs* Working Group evaluated the published scientific eviden with regards to the carcinogenic hazards from exposure to radiofrequency electromagnetic fields (RF-EMF). About 900 publications on RF-EMF and cancer were reviewed, covering

- exposure data
- epidemiology of human cancer
- cancer in experimental animals
- mechanistic and other relevant data

The Working Group considered three sources of exposure to RF-EMF:

- environmental sources
  broadcast antennas, base stations, medical devices, smart meters, Wi-Fi
- occupational sources
  high-frequency dielectric and induction heaters, radar installations
- personal devices
  cordless telephones, mobile telephones (cell phones), *Bluetooth*

Exposures from a mobile telephone

Holding a mobile phone to the ear can result in high specific absorption-rate (SAR) values in the brain, depending on the position of the phone and its antenna, and the quality of the connection with the base-station.

For children – compared with adults – the average deposition of RF-energy from a mobile phone can be up to 2-fold higher in the brain and up to 10-fold higher in the bone marrow of the skull.

The use of hands-free kits lowers exposure to the brain to <10% of the value resulting from use at the ear.

Exposure data

Sources of Radiofrequency Electromagnetic Fields [1)]

Source	Frequency	Exposure Level (mW/cm^2)	Distance	Time	Spatial features
Cell phone	900 MHz, 1800 MHz	1–5	At ear	During call	Highly localized
Cell-phone base station	900 MHz, 1800 MHz	0.000005–0.002	50 to a few thousand feet	Constant	Relatively uniform
Microwave oven	2450 MHz	~50 .05-0.2	2 inches 2 feet	During use	Localized, non-uniform
Local area networks (Wi-Fi)	2.4–5 GHz	0.0002–0.001 (wireless router)	3 feet	Constant when nearby	Localized, non-uniform
Radio/TV broadcast	Wide spectrum	0.001 (top 1% of the population)	Far from source (in most cases)	Constant	Relatively uniform
Smart meter	900 MHz, 2400 MHz	0.002-0.0002 (1 W, 5% duty cycle)	3-10 feet	When in proximity during transmission	Localized, non-uniform

1. EPRI, Electric Power Research Institute (2011) Radio-Frequency Exposure Levels from Smart Meters: A Case Study of One Model

Epidemiology

Occupational exposure to RF-EMF: some positive but inconsistent signals

	cases/controls	relative risk (95%CI)	
Thomas *et al.* 1987	435/386	1.7 (1.1–2.7)	Brain cancer

A death-certificate-based case-control study, with job title as proxy for RF-EMF exposure. Excess risk was attenuated when workers exposed to soldering fumes or lead were excluded: OR, 1.4 (0.7-3.1).

Grayson *et al.* 1996	230/920	1.39 (1.01–1.90)	Brain cancer

A large case-control study among US Air Force personnel exposed to equipment producing RF-EMF. Exposure assessment relied on job title and time of deployment, cancer cases were taken from hospital discharge records, but were not confirmed.

	cohort	relative risk (95%CI)	
Lagorio *et al* 1997	682	5.0 (1.3–27.9)	Leukaemia/lymphoma

A mortality study among workers in a plastic-ware industry, with exposure to RF-EMF (during sealing), and to vinyl chloride monomer. The study is small, possible confounding is not addressed.

Degrave *et al* 2009	2932	7.2 (1.1–48.9)	Leukaemia/lymphoma

Cause-specific mortality study among Belgian soldiers in batallions equipped with radar. Follow-up problematic; co-exposure to ionizing radiation suggested

Environmental exposure to RF-EMF: no solid data

Ecological and case-control studies have been carried out to investigate potential associations of brain cancer with RF emissions from transmission antennas. These studies are generally limited by reliance on measures of geographic proximity to the antennas as an exposure surrogate. Substantial exposure misclassification is unavoidable. For the same reason, no conclusions can be drawn from the limited data that were available on risk for leukaemia, lymphoma or a number of other cancers.

Personal exposure to RF-EMF: mobile telephone use

Three types of study addressed the question of cancer risk and mobile-phone use

- Ecological studies on time trends of disease rates.
  These analyses covered the period of the late 1990s and early 2000s, i.e. before mobile phone use became widespread.
- Cohort study
  A total of 257 cases of glioma were found in 420,095 subscribers to two Danish telephone companies, with 253.9 expected. Having a subscription was taken as a surrogate for phone use. The study suffers from exposure misclassification.
- Case-control studies: Overall, these studies provide the strongest evidence to date.

Case-control studies on mobile phone use

Muscat *et al* (2000), Inskip *et al* (2001), and Auvinen *et al* (2002) published early studies in the period of increasing use, with exposure assessment by self-reported history or by subscription records, and imprecise effect estimates.

	Phone type	Odds ratio (95%CI)	(from: Auvinen *et al*, 2002)
Glioma (n=398)	all phones	1.5 (1.0–2.4)	
	digital phones	1.0 (0.5–2.0)	
	analog phones	2.1 (1.3–3.4)	(analog wireless phones emit more RF-energy)

INTERPHONE (Cardis *et al.*, 2010), a multicentre case-control study of mobile-phone use and brain tumours, including glioma, acoustic neuroma, and meningioma.

The pooled analysis included 2708 glioma cases and 2972 controls (2000–2004; participation rates 64% and 53%, resp.). Ever/never use of a mobile phone yielded an OR of 0.81 (0.70-0.94). Odds ratios were uniformly below or close to unity for all deciles of exposure except for the highest decile (cumulative call time, >1640 hrs): OR, 1.40 (1.03–1.89).

Studies from Sweden (pooled analysis, Hardell *et al.*, 2011)

The analysis included 1148 glioma cases (ascertained in 1997–2003) and 2438 controls obtained through cancer/population registries. Questionnaires and telephone interviews were used to obtain information on use of mobile and cordless phones (response rates 85% and 84%). Those who had used a phone for >1 year had an OR for glioma of 1.3 (95% CI 1.1–1.6), which increased with longer time since first use and with total call time, to 3.2 (2.0–5.1) for > 2000 hours of use.

Although both the INTERPHONE study and the Swedish studies are susceptible to bias, the Working Group concluded that the findings cannot be dismissed as reflecting bias alone, and that a causal interpretation is possible. A similar conclusion was drawn for acoustic neuroma, from these studies and from a Japanese study. For meningioma, parotid-gland tumours, leukaemia, lymphoma, and other cancers, the Working Group found the evidence insufficient to reach a conclusion.

The Working Group concluded: there is *limited evidence* in humans for the carcinogenicity of RF-EMF, based on positive associations between glioma and acoustic neuroma and exposure to RF-EMF from wireless telephones.

The Working Group reviewed more than 40 studies that assessed the carcinogenicity of RF-EMF in rodents. Exposures included 2450-MHz RF-EMF and various RF-EMF types that simulated emissions from mobile phones. Increased cancer incidences were noted in 2/12 studies with tumour-prone animals, in 1/18 studies with initiation-promotion protocols, and in 4/6 co-carcinogenesis studies after exposure to RF-EMF in combination with a known carcinogen.

The Working Group concluded that there is *limited evidence* in experimental animals for the carcinogenicity of RF-EMF.

The Working Group reviewed many studies with endpoints relevant to mechanisms of carcinogenesis, including genotoxicity, effects on immune function, gene and protein expression, cell signalling, oxidative stress, apoptosis, effects on the blood-brain barrier, etc. There was evidence of an effect of RF-EMF on some of these endpoints, but the results provided only weak mechanistic evidence relevant to RF-EMF-induced cancer in humans.

Radiofrequency electromagnetic fields are *possibly carcinogenic to humans* (Group 2B)

Legislazione Italiana (DPCM 08/07/2003)

Valori limite di intensità di campo elettrico per l'esposizione a Radiofrequenze per la popolazione:

Valore limite per la popolazione	3-3000 MHz: 20 V/m
Valore di attenzione per permanenze ≥ 4 ore/giorno	0,1 MHz-300GHz: 6 V/m
Obiettivo di qualità per aree intensamente frequentate	0,1 MHz-300GHz : 6 V/m

Esposizione residenziale a radiofrequenze: Il caso di Radiovaticana

American Journal of Epidemiology

Vol. 155, No. 12
Printed in U.S.A.

Adult and Childhood Leukemia near a High-Power Radio Station in Rome, Italy

Paola Michelozzi,[1] Alessandra Capon,[2] Ursula Kirchmayer,[1] Francesco Forastiere,[1] Annibale Biggeri,[3] Alessandra Barca,[2] and Carlo A. Perucci[1]

Some recent epidemiologic studies suggest an association between lymphatic and hematopoietic cancers and residential exposure to high-frequency electromagnetic fields (100 kHz to 300 GHz) generated by radio and television transmitters. Vatican Radio is a very powerful station located in a northern suburb of Rome, Italy. In the 10-km area around the station, with 49,656 residents (in 1991), leukemia mortality among adults (age >14 years; 40 cases) in 1987–1998 and childhood leukemia incidence (eight cases) in 1987–1999 were evaluated. The risk of childhood leukemia was higher than expected for the distance up to 6 km from the radio station (standardized incidence rate = 2.2, 95% confidence interval: 1.0, 4.1), and there was a significant decline in risk with increasing distance both for male mortality ($p = 0.03$) and for childhood leukemia ($p = 0.04$). The study has limitations because of the small number of cases and the lack of exposure data. Although the study adds evidence of an excess of leukemia in a population living near high-power radio transmitters, no causal implication can be drawn. There is still insufficient scientific knowledge, and new epidemiologic studies are needed to clarify a possible leukemogenic effect of residential exposure to radio frequency radiation. *Am J Epidemiol* 2002;155:xxx–xxx.

child; geography; incidence; leukemia; mortality; radio

Health effects of microwave and radio frequency exposure (10 kHz to 300 GHz) have become a matter of increasing public concern in recent years owing to the growth of telecommunication systems. International guidelines for radio-frequency exposure for the general population (1) have been set to avoid thermal effects because other negative health effects have not yet been documented. The recent revision of these guidelines establishes maximum power flux density ranges of 200–1,000 $\mu W/cm^2$ in the frequency range of 10 MHz to 300 GHz as maximum power flux density allowed. Italian law (2) has recently adopted even lower thresholds (100 $\mu W/cm^2$ in the range of 3 MHz to 3 GHz and 400 $\mu W/cm^2$ in the range of 3–300 GHz) and has established the limit of 20 V/m (measure unit for electric field) for outdoors and 6 V/m for indoors when the exposure is more than 4 hours.

Although there is no conclusive scientific evidence of a causal link between radio frequency and cancer, public awareness about potential carcinogenic effects is growing, and there is an increased demand for epidemiologic investigations in the population residing around transmitters. Despite earlier suggestions of an increased risk of leukemia in populations living near radio television transmitters (3, 4), a recent evaluation of human studies on radio frequency and cancer has concluded that there is no consistent evidence of an effect and that "current epidemiologic evidence justifies further research" (5, p. 166).

The Vatican Radio station, located at the northwest edge of Rome, Italy, is a very powerful station that transmits all over the world. After the concern of the population regarding possible health effects associated with the station, epidemiologic investigations were requested by the regional government. The objective of this study was to evaluate the mortality risk for leukemia among adults and the incidence of childhood leukemia in the population living at increasing distances from the radio station by using a geographic analysis approach.

MATERIALS AND METHODS

Vatican Radio station

The radio station was installed in 1957, in an area that covers 2 km in the direction north/south and 1.5 km in the direction east/west. There are numerous transmitters with different emission directions (three rotating and 28 fixed antennas), different transmission powers (ranging from 5 to 600 kW), and different frequency ranges (nine transmitters for short waves, with frequencies of 4,005–21,850

Received for publication June 19, 2002, and accepted for publication February 2, 2002.

Abbreviations: CI, confidence interval; RR, relative risk; SIR, standardized incidence ratio; SMR, standardized mortality ratio.

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[2] Agency for Public Health, Lazio, Italy.
[3] Department of Statistics, University of Florence, Florence, Italy.
Reprint requests to Dr. Paola Michelozzi, Department of Epidemiology, Lazio, Via S. Costanza, 53, 00198 Rome, Italy (e-mail: salute@asplazio.it).

A Cesano viene segnalato dalla ASL un aumento del 30% della mortalità per tumori a seguito della denuncia del medico di base

Interrogazioni parlamentari e del consiglio regionale chiedono l'attivazione di un'indagine; L'OER incaricato dall'Assessore alla Sanità di attivare studio epidemiologico

È presente nell'area un
eccesso di incidenza
di tumori e/o
di mortalità per tumori

?

Cronologia

1996-97 ***Vengono pubblicati tre studi (Hocking et al.1996; Dolk et al. 1997a, Dolk et al. 1997b) che suggeriscono una possibile associazione tra esposizione residenziale a RF e incidenza di leucemie***

Cronologia

1998 **Primo Rapporto OER sull'analisi della mortalità per leucemie, 1987-95 (studio caso-controllo e analisi geografica)**

L'indagine viene estesa all'incidenza di leucemie infantili (aa 1987-99); aggiornamento dell'analisi della mortalità al 1998 (solo analisi geografica)

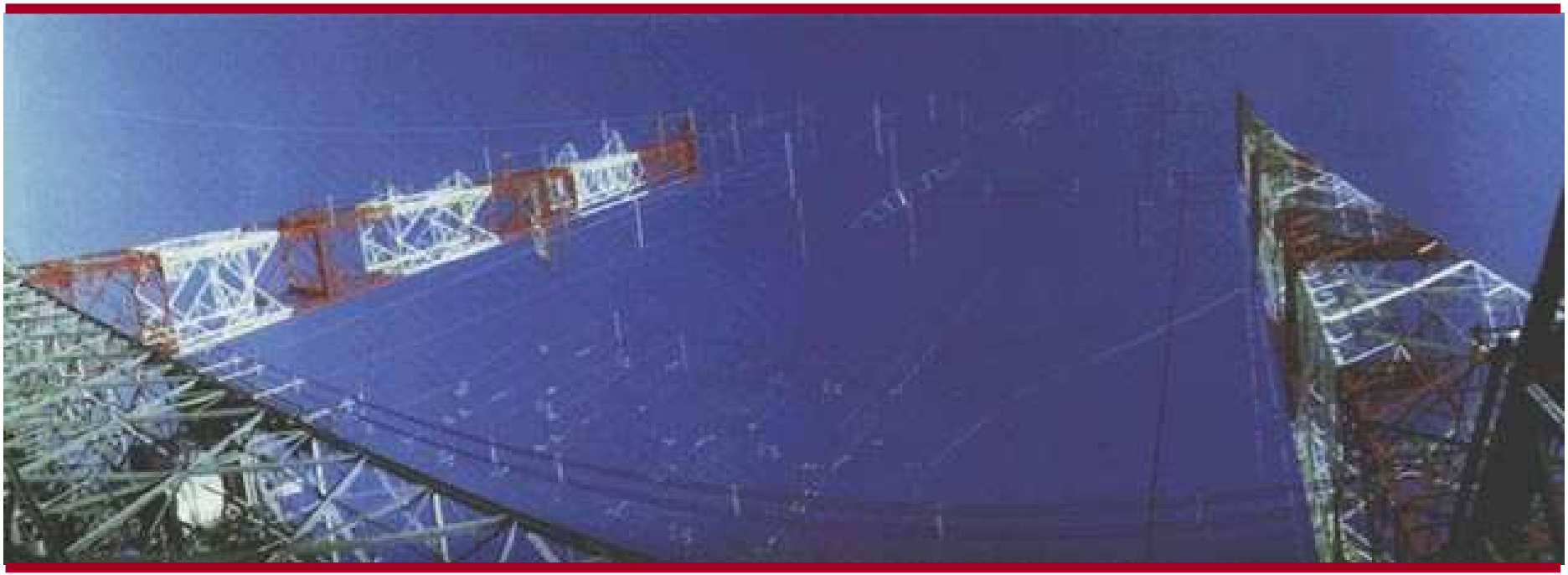
2001 **Secondo Rapporto dell'ASP del Lazio**
aprile: Controdeduzioni Prof S.Tiberti (Università dell'Aquila)
aprile: Osservazioni al documento "Controdeduzioni" P.Comba, ISS
settembre:Relazione del gruppo di studio del Ministero della Sanità (Donato Greco, Peter Boyle, G.Masera, R.Mertelsmann)

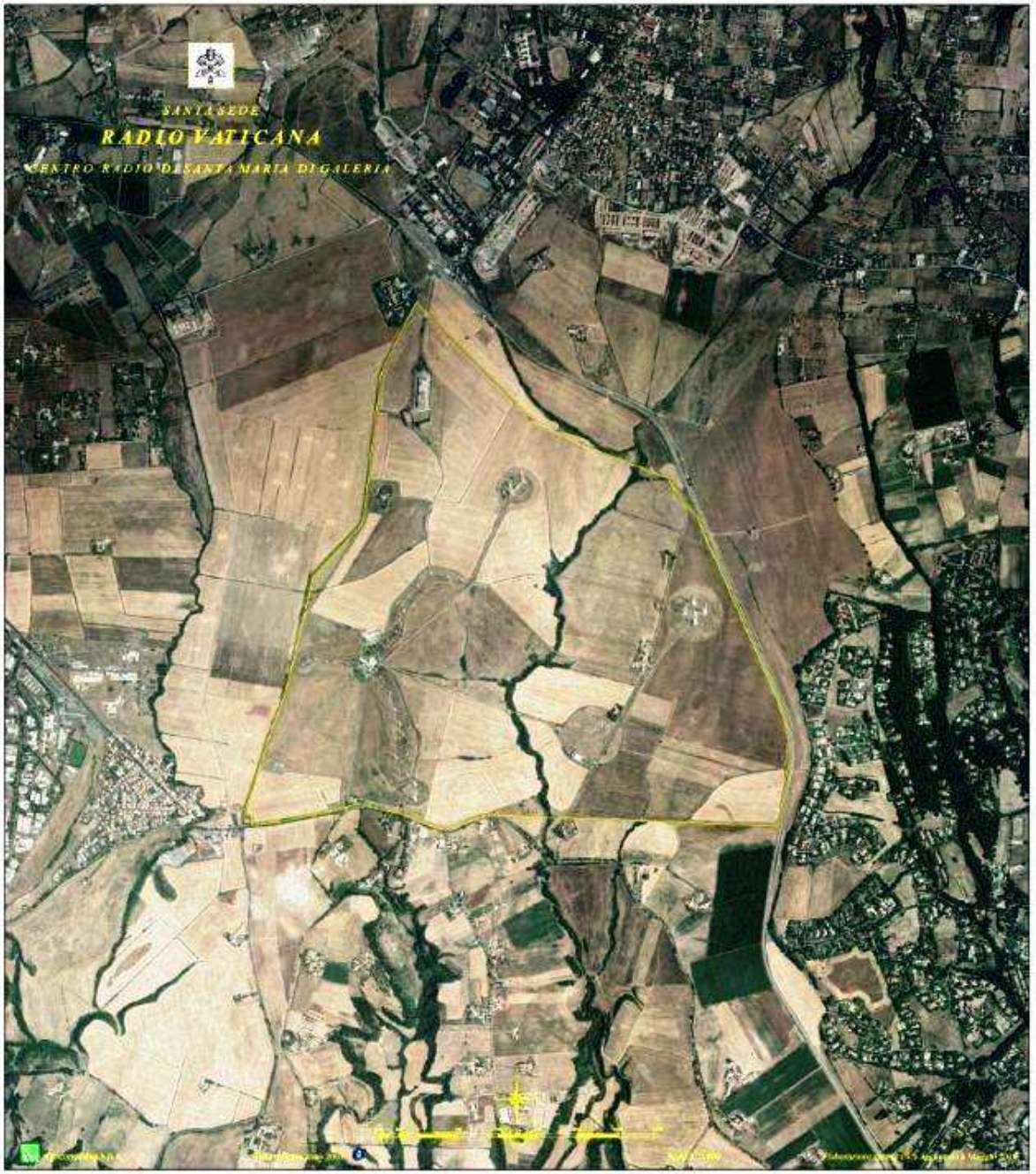
Fonte di emissione: stazione di Radio Vaticana

Installata nel 1957. E' localizzata a nord di Roma e si estende su un'area di circa 4 km^2 .

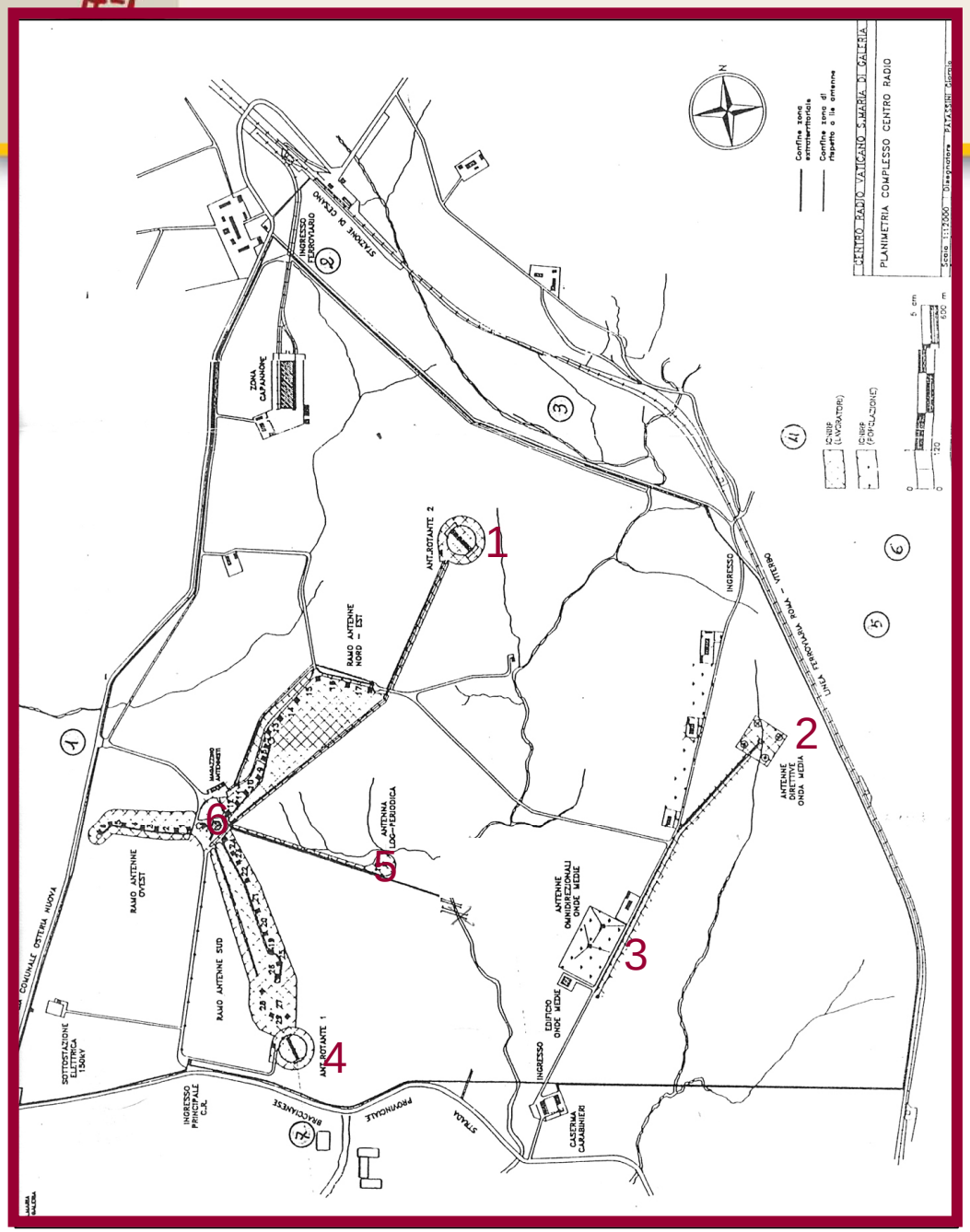
Comprende numerose antenne (2 antenne rotanti e 28 antenne fisse) caratterizzate da:

- diverse direzioni di emissione
- diversa potenza (5 kW to 600 kW)
- diverse frequenze di emissione (onde corte: 4005-21850 kHz, onde medie 527-1611 kHz)
- programmi nazionali ed internazionali trasmessi a diversi orari




SANTA SEDE
RADIO VATICANA
CENTRO RADIO DI SANTA MARIA DI GALERIA

Planimetria della stazione radio



1. Antenna rotante n. 2
2. Antenne direttive onde medie (4 torri)
3. Antenne omnidirezionali onde medie
4. Antenna rotante n.1
5. Antenna log periodica
6. Centro antenne filari fisse

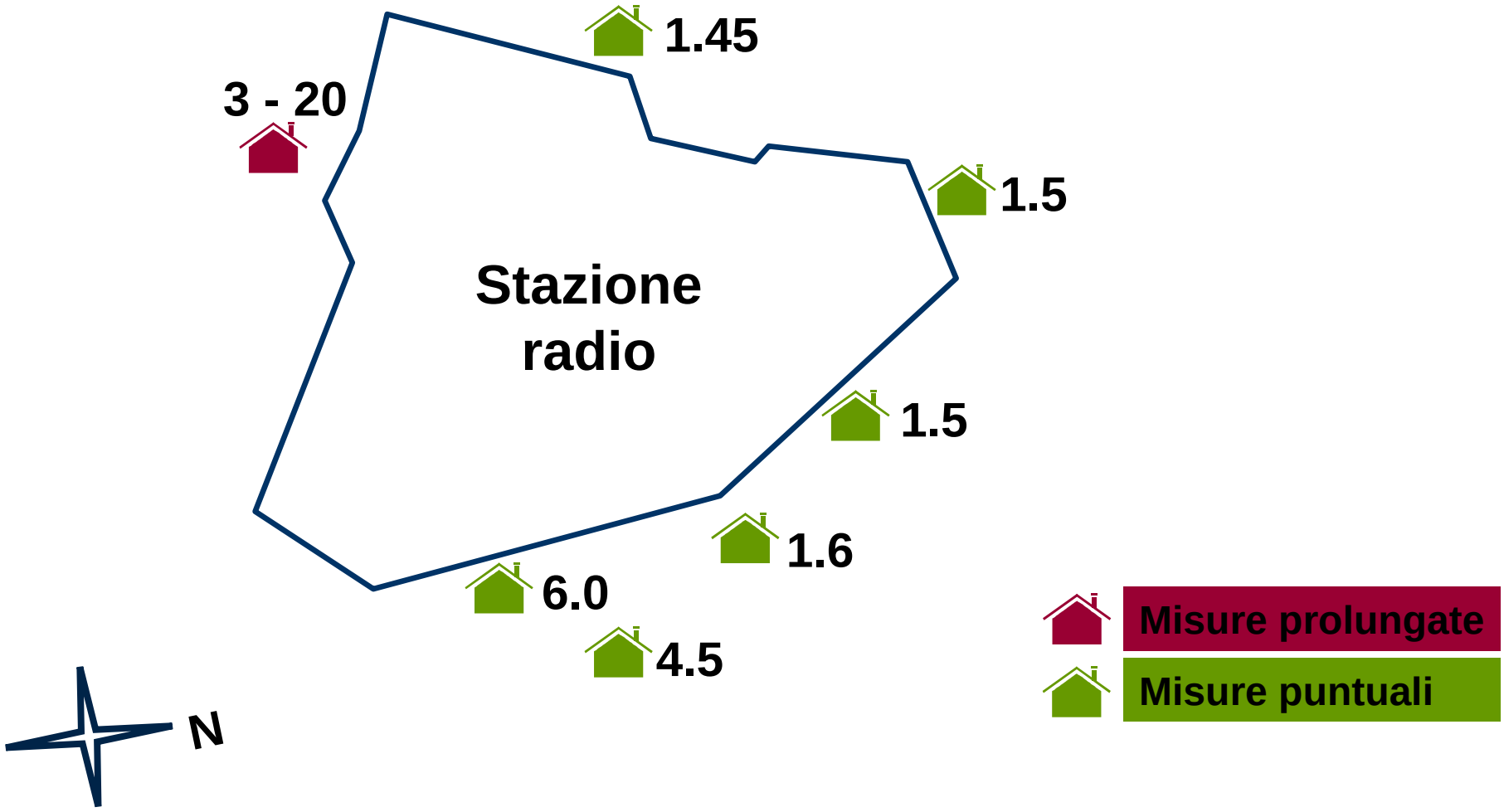
Misure del campo elettrico

ENEA, ANPA e ARPA hanno effettuato negli anni diverse rilevazioni di campo elettrico in aree vicine agli impianti

Un rapporto dell' ENEA sulle misure di campo elettrico effettuate su un campione di edifici localizzati entro 600 m dal muro di cinta riportano valori interni alle abitazioni tra 1,5 – 6,0 V/m, e valori esterni tra 10 e 20 V/m. (1998)

Assenti misure che indicano la variazione del campo elettrico/magnetico a distanze crescenti dagli impianti

Misure di campo elettrico (V/m) in un campione di edifici in prossimità della stazione radio



Metodi (I) Area e popolazione in studio

- Definizione di un punto centrale della stazione radio
- L'area in studio (314 km2) è definita da un cerchio di raggio di 10 km intorno a questo punto.
- La popolazione totale (al censimento '91) era pari a 48556 residenti, di cui 8324 bambini nella classe di età 0-14 anni

Metodi (II)

Mortalità: decessi per leucemia (ICD-IX: 2040-2089) nella popolazione adulta nell'area in studio. 1987-98 (fonte:Registro regionale della Mortalità per Causa)

Incidenza: casi di leucemia infantile (0-14 anni) diagnosticati tra i residenti nell'area in studio. 1987-99 (Fonte: Registro regionale tumori infantili)

Esposizione: distanza tra il centroide della sezione di censimento della residenza (alla diagnosi/decesso) e il piunto centrale della stazione radio

Metodi (II)

Esposizione: distanza tra il centroide della sezione di censimento della residenza (alla diagnosi/decesso) e il punto centrale della stazione radio

Uso della distanza
(assenza di misure dirette)

In condizioni di campo libero la densità di potenza del campo elettromagnetico varia con l'inverso del quadrato della distanza

Metodi (III) Analisi statistica

- Test di Stone condizionato per l'andamento del rischio in funzione della distanza.Utilizza dati aggregati (OSS/ATT per piccole aree) *(Elliott P, 1992)*

Solo per l'analisi della leucemia infantile:

- Score Test *(Lawson AB, 1993)*
- Test del clustering *(Waller L, Poquette CA, 1993)*

Risultati

Mortalità per leucemia tra gli adulti (>14 anni). Casi osservati (OSS), SMR*, IC 95 % in corone concentriche e aree cumulate . Risultati del test di Stone, 1987-1998

CORONE	0 – 2 km		2 – 4 km		4 – 6 km		6 – 8 km		8-10 km	
	OSS	SMR	OSS	SMR	OSS	SMR	OSS	SMR	OSS	SMR
uomini	2	290	6	163	7	97	5	80	1	23
donne	0	-	3	129	5	106	6	145	5	138
totale	2	178	9	150	12	101	11	106	6	75

AREE CUMULATE	0 – 2 km		0 – 4 km		0 – 6 km		0 – 8 km		0-10 km	
	OSS	SMR	OSS	SMR	OSS	SMR	OSS	SMR	OSS	SMR
uomini	2	290	8	183	15	130	20	112	21	95
donne	0	-	3	109	8	107	14	120	19	125
totale	2	178	11	154	23	121	34	116	40	107

TEST DI STONE		
	uomini	p=0,03
	donne	p=0,86
	totale	p=0,14

* Aggiustato per livello socioeconomico

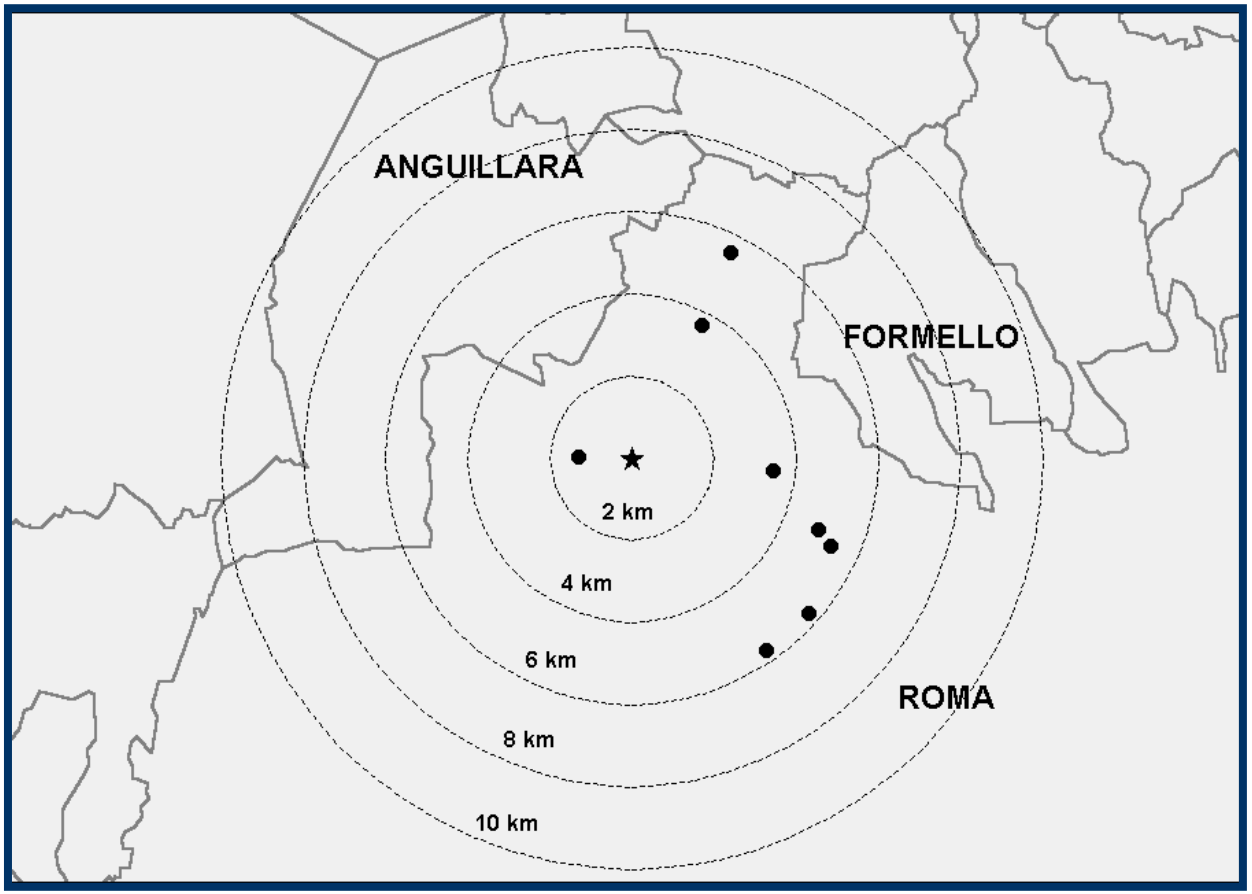
Risultati

Incidenza di leucemia infantile . Elenco dei casi osservati con anno di diagnosi, sesso, età alla diagnosi, patologia, durata della residenza. 1987-99

	anno diagnosi	sesso	età	Patologia*	distanza (km)	durata della residenza
1	1989	f	2	LLA	4.79	dalla nascita
2	1991	f	12	LMA	3.33	5 anni
3	1993	m	9	LLA	1.37	dalla nascita
4	1996	m	0	LLA	5.56	dalla nascita
5	1997	m	5	LLA	5.79	2 anni
6	1998	f	7	LLA	5.21	dalla nascita
7	1998	f	1	LLA	3.65	dalla nascita
8	1998	m	4	LLA	5.79	dalla nascita

***LLA = Leucemia linfoide acuta**
LMA = Leucemia mieloide acuta

Localizzazione dei casi di leucemia infantile (0-14 anni) a distanze crescenti (incrementi di 2 km) dalla stazione di radio vaticana. 1987- 99



Risultati

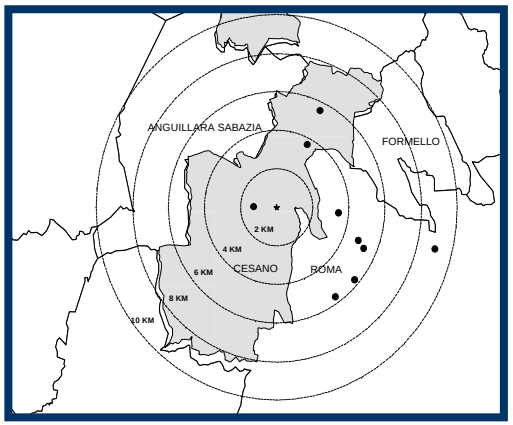
Incidenza di leucemia infantile (0-14 anni). Numero di casi osservati (OSS), rapporto standardizzato di incidenza (SIR*), IC 95 % in aree concentriche (corone e cerchi di raggio crescente). 1987-99

Corone	0 – 2 km		2 – 4 km		4 – 6 km		6 – 8 km		8-10 km	
	OSS	SIR	OSS	SIR	OSS	SIR	OSS	SIR	OSS	SIR
	1	6.07	2	2.32	5	1.87	0		0	
aree cumulate	0 – 2 km		0 – 4 km		0 – 6 km		0 – 8 km		0-10 km	
	OSS	SIR	OSS	SIR	OSS	SIR	OSS	SIR	OSS	SIR
	1	6.07	3	2.92	8	2.17*	8	1.47	8	1.22
TEST DI STONE	p=0.04									

* Aggiustato per livello socioeconomico

Risultati

Analisi di sensibilità



5 corone (incrementi di 2 km)

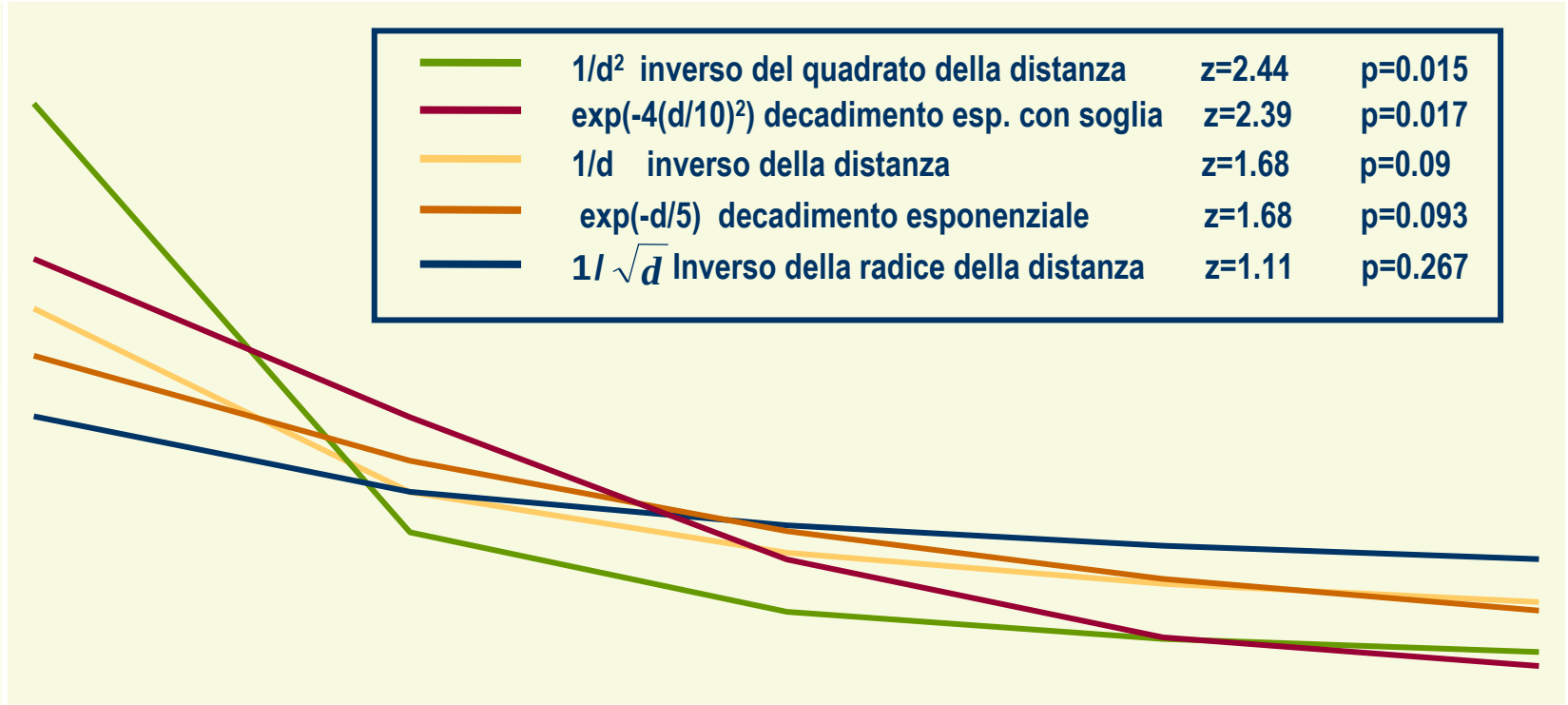
- tutti i casi p=0.004
- senza il caso più vicino (0-2 km) p=0.013
- senza i 2 casi non residenti dalla nascita p=0.013
- aggiungendo un caso nella corona 8-10 km p=0.063

3 corone (0-2 km;2-4 km;4-10 km)

- tutti i casi p=0.036
- senza il caso più vicino (0-2 km) p=0.210
- senza i 2 casi non residenti dalla nascita p=0.059

Risultati

Score Test



Distanza (km)

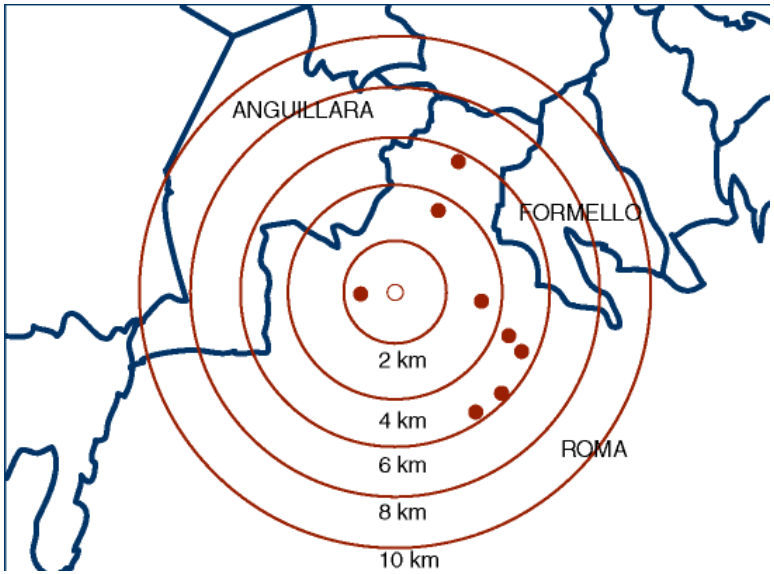
Risultati: test del clustering

I risultati non evidenziano nel comune di Roma aggregazioni spaziali (clustering) di casi entro e tra sezioni di censimento.

Potthoff – Whittinghill Test: p-value=0.786
(IARC,1996)

Test per i cluster

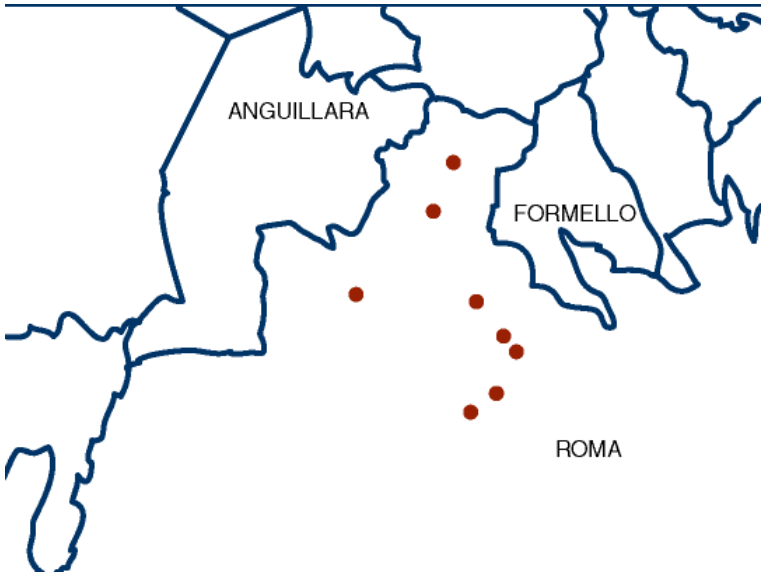
Eliminando come punto di partenza il centro della stazione radio non è identificabile nell'area un cluster spaziale di casi



Scan Test, Kulldorff e Nagarwalla, Statistics in Medicine (1995)

Test per i cluster

Eliminando come punto di partenza il centro della stazione radio non è identificabile nell'area un cluster spaziale di casi



Scan Test, Kulldorff e Nagarwalla, Statistics in Medicine (1995)

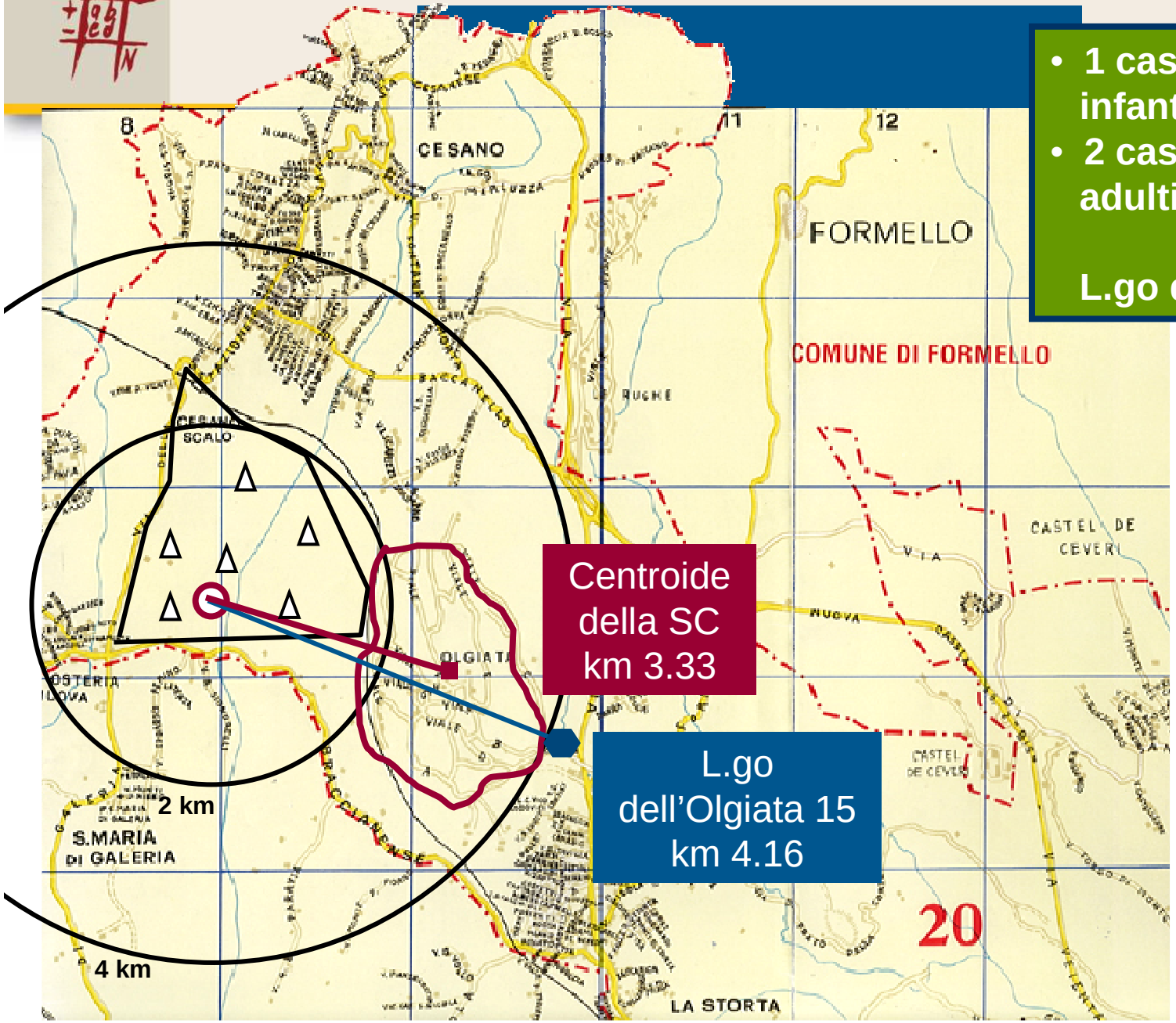
Aspetti metodologici

1. centroide S.C
   vs
   residenza esatta
   (accuratezza e completezza dell'informazione)

2. dati aggregati
   vs
   dati individuali

3. Centro stazione
   vs
   singole emittenti

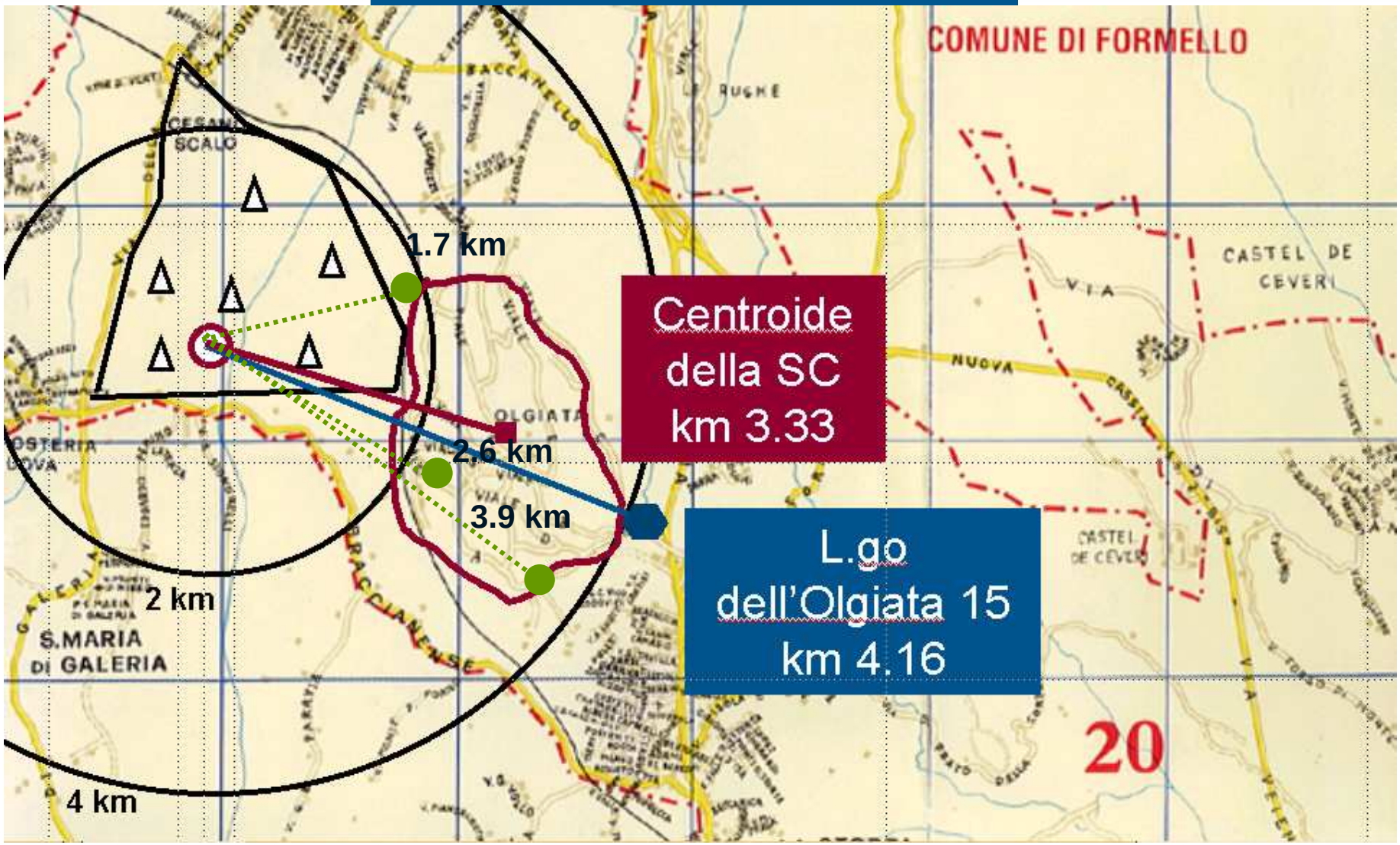
1. Localizzazione dei casi. Accuratezza e completezza dell' informazione



- 1 caso di leucemia infantile
- 2 casi di decessi adulti

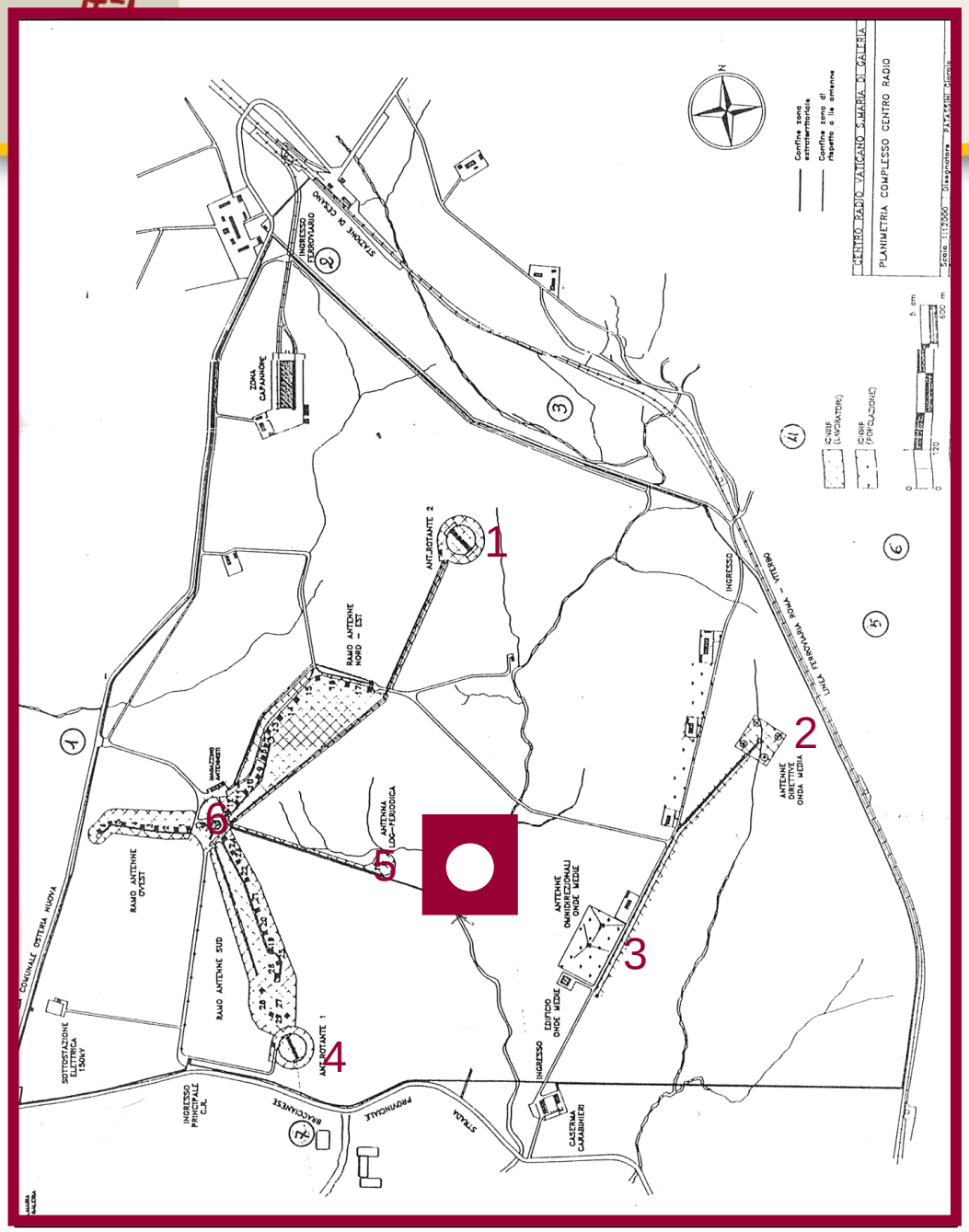
L.go dell'Olgiata 15

1. Localizzazione dei casi. Accuratezza e completezza dell' informazione



Dati individuali

Disegno caso-controllo



3. Fonte di inquinamento

Distanza dalle singole emittenti

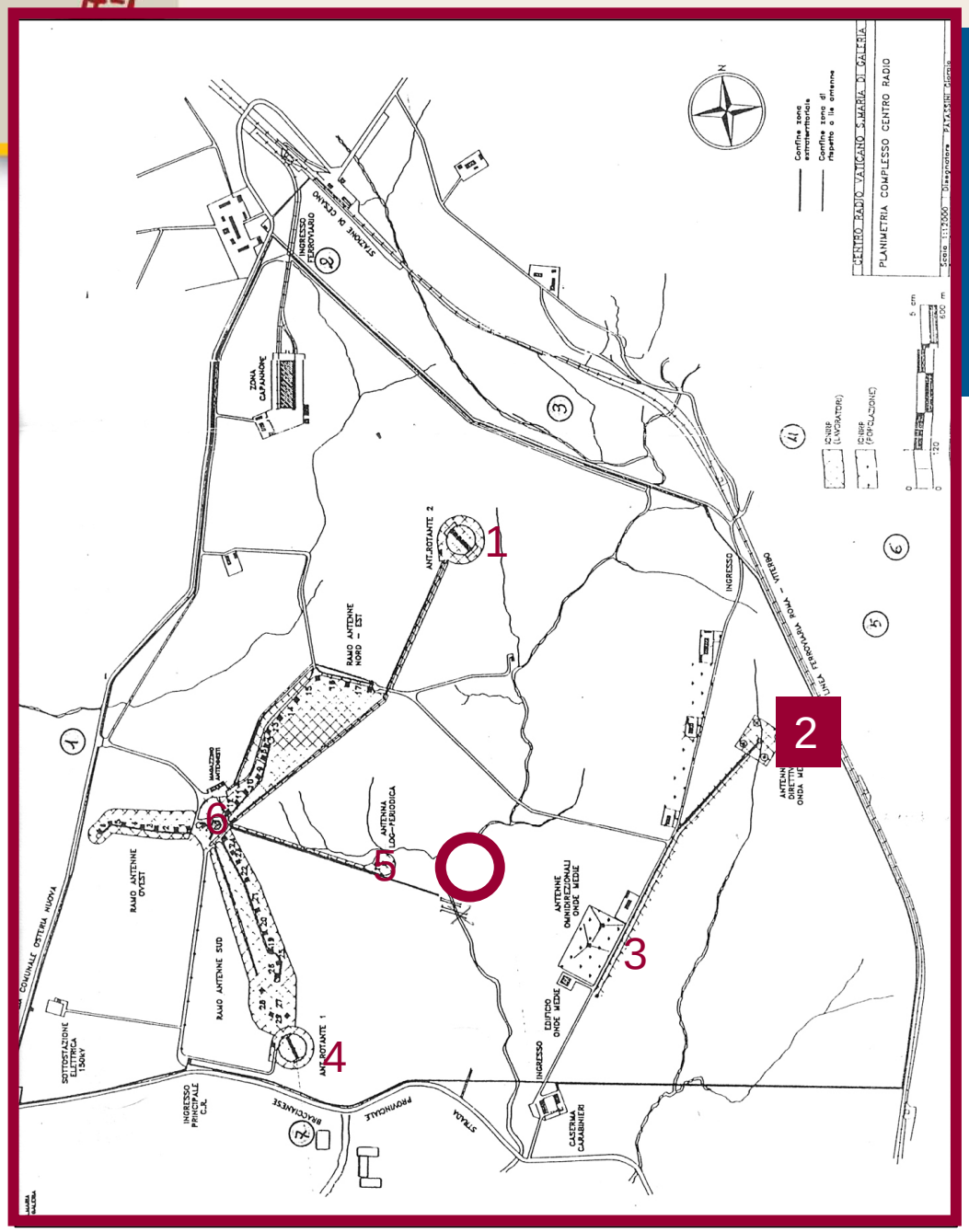
1. Antenna rotante n. 2
2. Antenne direttive onde medie (4 torri)
3. Antenne omnidirezionali onde medie
4. Antenna rotante n.1
5. Antenna log periodica
6. Centro antenne filari fisse

Centro stazione radio

Incidenza di leucemia infantile (1987-99) a diverse distanze della residenza dalle singole emittenti e dal centro della stazione radio.

	DISTANZA 0 - 2 km	0 - 4 km	0 - 6 km
centro			
osservati	2	3	6
SIR	**12.50***	2.94	1.63
Antenne onde medie (4 torri)			
osservati	1	3	6
SIR	6.25	2.25	1.69
antenna rotante 2			
osservati	2	4	6
SIR	**15.60***	2.76	1.86

*standardized incidence ratio



3. Distanza dalle singole emittenti

1. Antenna rotante n. 2
2. Antenne direttive onde medie (4 torri)
3. Antenne omnidirezionali onde medie
4. Antenna rotante n.1
5. Antenna log periodica
6. Centro antenne filari fisse

Centro stazione radio

	distanza	centro	4 torri	Antenna Rotante 2	Minima
		OR**	OR**	OR**	OR**
tot	> 3 km	1.00	1.00	1.00	1.00
	<= 3 km	3.62	4.65 *	2.89	2.68
	> 4 km	1.00	1.00	1.00	1.00
	<= 4 km	3.74	4.95 *	4.63	4.71
uomini	> 3 km	1.00	1.00	1.00	1.00
	<= 3 km	7.02	6.40 *	2.52	3.31
	> 4 km	1.00	1.00	1.00	1.00
	<= 4 km	5.55	6.85 *	3.55	5.32
donne	> 3 km	1.00	1.00	1.00	1.00
	<= 3 km	0.63	2.44	3.40	2.16
	> 4 km	1.00	1.00	1.00	1.00
	<= 4 km	2.09	3.31	7.37	4.51

**Aggiustato per sesso, classe di età e livello socioeconomico

* P value < 0.05

Principali limiti

- **Distanza come misura di esposizione (assenza di misure dirette)**
- **Confondenti (campi magnetici a bassa frequenza, raggi gamma, agenti chimici?)**

Conclusioni

- **Lo studio documenta un eccesso di rischio di leucemia in prossimità della stazione radio e un decremento del rischio a distanza crescente dagli impianti**

- **Le analisi che utilizzano la residenza esatta confermano i risultati dell'analisi con dati aggregati (sezioni di censimento)**

- **I risultati indicano la necessità di un approfondimento attraverso studi analitici con misure dirette di esposizione**

Conclusioni

“I risultati di questo studio, assieme alle evidenze prodotte in studi analoghi, non forniscono evidenze conclusive circa una possibile associazione causale tra esposizione a RF e aumento del rischio di leucemie, anche a causa del carattere ecologico degli studi effettuate fino ad oggi”

PROCEDIMENTO PENALE N. 33642/03

PERIZIA MEDIANTE INDAGINE EPIDEMIOLOGICA

INCIDENTE PROBATORIO

Milano, 25 giugno 2010

Dott. ANDREA MICHELI

Incarico conferito il 31 luglio 2006

GIP dott.ssa Zaira Secchi

“ MARCONI ha indagato sui possibili eccessi di mortalità per leucemia e per l'insieme dei tumori del sistema emolinfopoietico per quanto concerne gli studi di mortalità, e sui possibili eccessi nell'incidenza di leucemia e linfomi tra i bambini nell'area in studio” .

Perizia Marconi: casi incidenza leucemie, classe di età 0-14,

Tabella N.N.I.1. Distribuzione dei casi secondo la nosologia nello studio di incidenza relativo a Radio Vaticana e Maritele (Studio I.1)

STUDIO I.1	*ICD-9*	*In studio n*	*In analisi*		
			n	%	Età minima e massima al decesso
Leucemia Linfatica Acuta	204.0	27	25	64,1	0 - 13
Altre leucemie	207	4	2	5,1	7 - 14
Totale leucemie	**204-208**	**31**	**27**	**69,2**	0 - 14
Linfoma Non Hodgkin	202	8	4	10,3	4 - 12
Linfoma di Hodgkin	201	8	8	20,5	5 - 14
Totale casi	**200-208**	**47**	**39**	**100**	**0 - 14**

“Lo studio MARCONI suggerisce che vi sia stata un'associazione importante, coerente e significativa tra esposizione residenziale all'emittente ed eccesso di rischio di morte per leucemia.”

Risultati

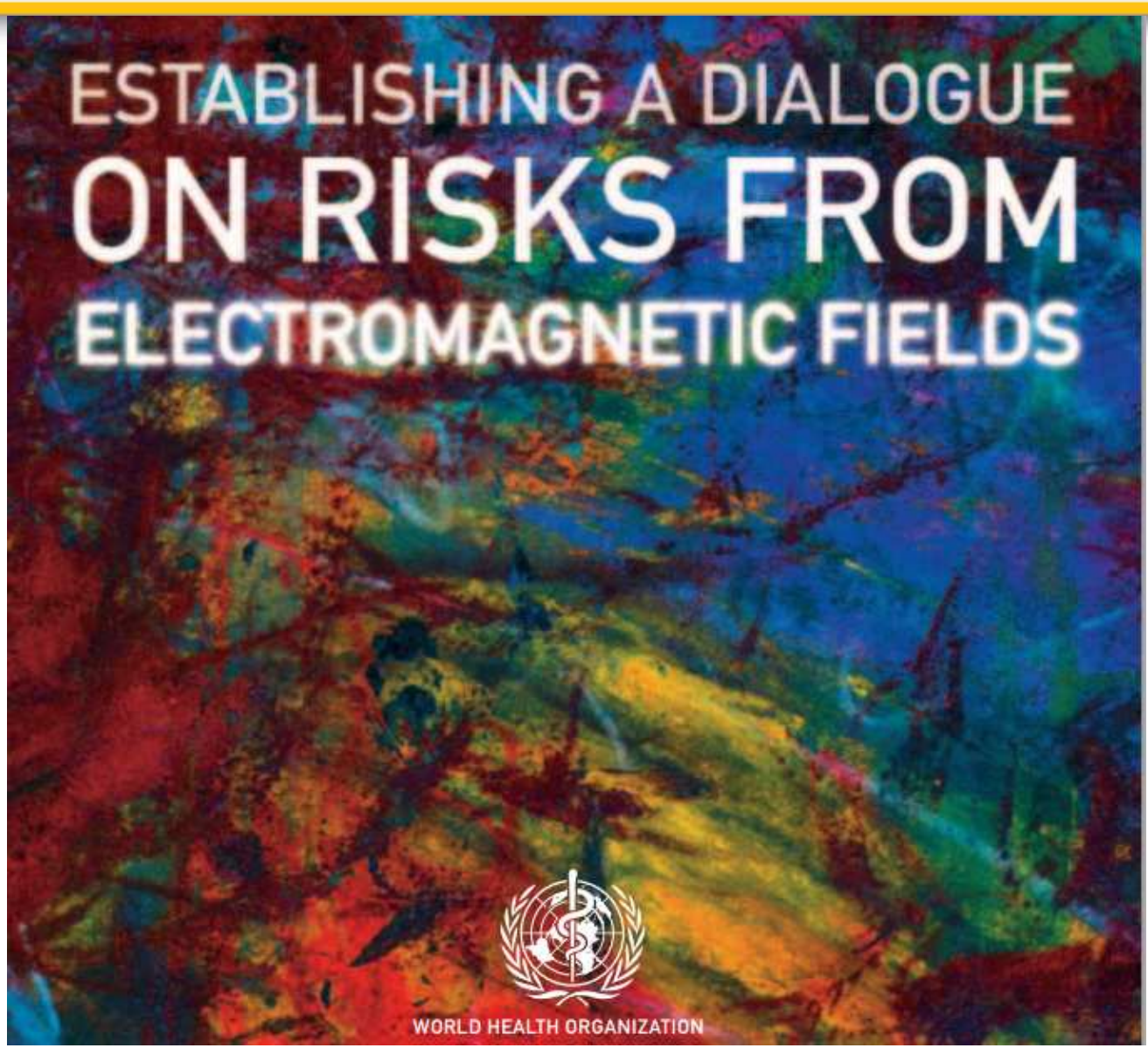
Gli incrementi di rischio cui il perito annette grande risalto vengono riepilogati nelle tabelle seguenti , relative la prima allo studio M1.1 e l seconda allo studio I.1.

Studio	Tabella	Neoplasia	Distanza	Sesso	OR	IC 95%			CLR
M1.1	BM11	SLEP	5-9 km	M+F	3,12	1,00	-	9,69	10
M1.1	ADM11	SLEP	6-12 km	F	4,79	1,04	-	21,91	21
M1.1	BAM11	SLEP	6-12 km	M+F Adulti	3,44	1,05	-	11,27	11
M1.1	ALM11	Leucemia	6-12 km	M+F	6,69	1,45	-	30,78	21

Fonte: consulenza tecnica Veronesi, Lagorio

Le “*associazioni importanti e significative*” riguardano in realtà **storie residenziali che si sono svolte fuori dall’area considerata “*a rischio*”, cioè dal limite dei 6 km di distanza dal centro trasmissioni di Santa Maria di Galeria verso la zona che avrebbe dovuto essere considerata “*area di confronto*”.**

- ***Fonte: consulenza tecnica Veronesi, Lagorio***


ESTABLISHING A DIALOGUE
ON RISKS FROM
ELECTROMAGNETIC FIELDS
WORLD HEALTH ORGANIZATION

EMF RISK COMMUNICATION
DEALING WITH PUBLIC PERCEPTION

2

Modern technology offers powerful tools to stimulate a whole range of benefits for society, in addition to economic development. However, technological progress in the broadest sense has always been associated with hazards and risks, both perceived and real. Industrial, commercial and household applications of EMF are no exception. Around the start of the twentieth century people were worried about the possible health effects of light bulbs and the fields emanating from the wires on poles connecting land-based telephone systems. No adverse health effects appeared, and these technologies were gradually accepted as part of normal

the new technology is presented and how its risks and benefits are interpreted by an ever more wary public.

Throughout the world, some members of the general public have indicated concern that exposure to EMF from such sources as high voltage power lines, radar, mobile telephones and their base stations could lead to adverse health consequences, especially in children. As a result, the construction of new power lines and

countries. Public worry about new technologies often stems from unfamiliarity and a sense of danger from forces that they cannot sense.

Recent history has shown that lack of knowledge about health consequences of technological advances may not be the sole reason for social opposition to innovations. Disregard for differences in risk perception that are not adequately reflected in communication among scientists, governments, industry and the public, is also to blame. It is for this reason that *risk perception* and *risk communication* are major aspects of the EMF issue.

This section aims to provide governments, industry and members of the public with a framework to establish and maintain

DEFINING RISK

In trying to understand people's perception of risk, it is important to distinguish between a health hazard and a health risk. A *hazard* can be an object or a set of circumstances that could potentially harm a person's health. *Risk* is the likelihood, or probability, that a person will be harmed by a particular hazard.

HAZARD AND RISK

- Driving a car is a potential *health hazard*. Driving a car fast presents a *risk*. The higher the speed, the more risk is associated with the driving.
- Every activity has an associated risk. It is possible to diminish risks by avoiding specific activities, but one cannot abolish risk entirely. In the real world, *there is no such thing as a zero risk.*

MULTIPLE DETERMINANTS OF THE EMF RISK ISSUE

Scientists assess health risk by weighing and critically evaluating all of the available scientific

FIGURE 3. EVALUATING, INTERPRETING AND

assessment of risk by an entirely different process, often not based on quantifiable information. Ultimately this perceived risk could take on an importance as great as a measurable risk in determining commercial investment and government policy.

BASICS OF RISK ASSESSMENT

Risk assessment is an organized process used to describe and estimate the likelihood of adverse health outcomes from environmental exposures to an agent. The four steps in the process are:

1. **Hazard identification:** the identification of a potentially hazardous agent or exposure situation (e.g., a particular substance or energy source)
2. **Dose-response assessment:** the estimation of the relationship between dose or exposure to the agent or situation and the incidence and/or severity of an effect
3. **Exposure assessment:** the assessment of the extent of exposure or potential exposure in actual situations
4. **Risk characterization:** the synthesis and summary of information about a potentially hazardous situation in a form useful to decision-makers and stakeholders.

The factors that shape *risk perception* of individuals include basic societal and personal values (e.g. traditions, customs) as well as previous experience with technological projects (e.g. dams, power plants). These factors may explain local concerns, possible biases or hidden agendas or assumptions. Careful attention to the social dimensions of any project allows policy makers and managers to make informed decisions as part of a thorough *risk management* programme. Ultimately, risk management must take into account both measured and perceived risk to be effective (Figure 3).

The identification of problems and the scientific risk assessment of those problems are key steps to defining a successful risk management programme. To respond to that assessment, such a programme should incorporate actions and strategies, e.g. finding options, making decisions, implementing

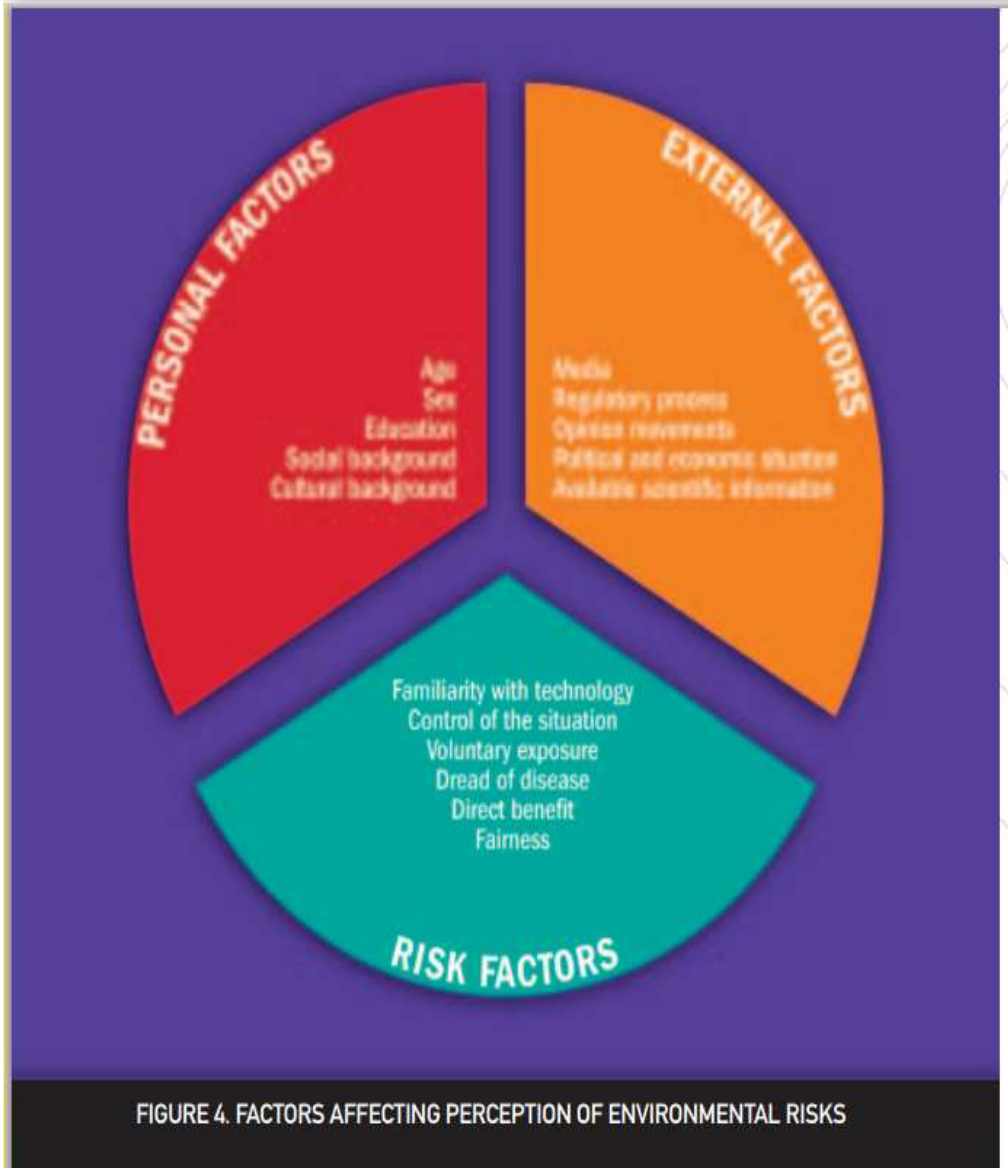


FIGURE 4. FACTORS AFFECTING PERCEPTION OF ENVIRONMENTAL RISKS

The *nature of the risk* can also lead to different perceptions. The greater the number of factors adding to the public's perception of risk, the greater the potential for concern. Surveys have found that the following pairs of characteristics of a situation generally affect risk perception.

- **FAMILIAR VS. UNFAMILIAR TECHNOLOGY.** Familiarity with a given technology or a situation helps reduce the level of the perceived risk. The perceived risk increases when the technology or situation, such as EMF, is new, unfamiliar, or hard-to-comprehend. Perception about the level of risk can be significantly increased if there is an incomplete scientific understanding about potential health effects from a particular situation or technology.
- **PERSONAL CONTROL VS. LACK OF CONTROL OVER A SITUATION.** If people do not have any say about installation of power lines and mobile telephone base stations, especially near their homes, schools or play areas, they tend to perceive the risk from such EMF facilities as being high.
- **VOLUNTARY VS. INVOLUNTARY EXPOSURE.** People feel much less at risk when the choice is theirs. Those who do not use mobile telephones may perceive the risk as *high* from the relatively low RF fields emitted from mobile telephone base stations. However, mobile telephone users generally perceive as *low* the risk from the much more intense RF fields from their voluntarily chosen handsets.
- **DREADED VS. NOT DREADED OUTCOME.** Some diseases and health conditions, such as cancer, or severe and lingering pain and disability, are more feared than others. Thus, even a small possibility of cancer, especially in children, from a potential hazard such as EMF exposure receives significant public attention.

I possibili rischi per la salute da esposizione a ELF e radiofrequenze continua a far discutere nel mondo scientifico

e il tema continua a rappresentare un difficile problema

per i politici e per gli amministratori

Link rapporti delle organizzazioni internazionali

Agenzia internazionale per la ricerca sul cancro (Iarc) – Monografie

http://monographs.iarc.fr/

Commissione europea – Comitato scientifico sui rischi sanitari emergenti e di nuova identificazione (Scenihr)

http://europa.eu.int/comm/health/ph_risk/committees/04_scenihr/04_scenihr_en.htm

Commissione europea – Progetto Emf-Net
http://web.jrc.ec.europa.eu/emf-net/

Commissione europea – Progetto Efrhan

http://efhran.polimi.it/

Commissione internazionale per la protezione dalle radiazioni non ionizzanti (Icnirp)

http://www.icnirp.org

Organizzazione mondiale della sanità (Oms) – Progetto internazionale campi elettromagnetici **http://www.who.int/peh-emf**