

RSM/COAI/019
February 21, 2011

The Telecom Regulatory Authority of India

Mahanagar Doorsanchar Bhawan
Jawahar Lal Nehru Marg (Old Minto Road)
Next to Zakir Hussain College
New Delhi – 110 002

Re: TRAI Consultation Paper on “Telecommunications Infrastructure Policy”

Dear Sir,

This is with reference to the TRAI stakeholders comments on the Consultation Paper on “Telecommunications Infrastructure Policy”. We would like to submit some additional/counter comments which are given below.

I. Reserving spectrum bands for provision of private GSM service (IBS Solutions) and deployment of DAS

- a) *In their response some of the respondents have stated that the business opportunity for setting up Private GSM networks, which would entail providing IBS solutions, and the deployment of DAS should be reserved for small entrepreneurs. It has been proposed that an amount of 3 MHz of Spectrum in 900 MHz, 1800 MHz and CDMA band should be reserved/ earmarked for these infrastructure providers who would set up IBS & DAS facilities and charge TSPs for providing these services.*
- b) Given the fact that all existing service providers are already deploying IBS and DAS to enhance network coverage and quality, the above suggestion of reserving this business opportunity and the spectrum for small/ medium enterprises is completely baseless and out of context in the present telecom scenario. In fact, this is equivalent to allowing MVNOs with allocation of spectrum.
- c) Reserving a spectrum band for only one class of operators would be equivalent to distorting the market in unknown ways. We request the TRAI not to consider such an approach.
- d) The Indian mobile market, being the second largest market in the world, has greatly evolved over the years and has done well. The concept of a “subsidy” or a “reservation” in the provision of telecom services or spectrum is not recommended by us. We believe that the current market has grown commendably as it was based on market forces and competition. Any intervention with the pure play of market forces will only act as a deterrent to the growth of service.
- e) COAI therefore strongly recommends that neither the business opportunity nor the spectrum should be reserved for deployment of IBS or DAS solutions. The existing mobile

service providers, driven by intense competition, are already taking care of coverage and quality related aspects. With the already considerable shortage of spectrum we do not subscribe to any kind of reservation as proposed.

III. EMF/ Health related issues

COAI submits that report/submission of Prof. Girish Kumar contains several incorrect perspectives and does not provide a balanced view on this very important issue. The Report does not take into account a complete body of research studies by reputed international institutes like World Health Organization, British Medical Association, International Commission on Non-Ionizing Radiation Protection (ICNIRP), Food And Drug Administration (USA), Indian Council for Medical Research, etc. and general consensus of these studies does not demonstrate any conclusive link between human health risks and the use of digital mobile phones or living near a base station.

Moreover, it has also failed to appreciate that the science-based safety standards prescribed by ICNIRP and endorsed by WHO are reliable safeguards for all segments of the population, including children and it is these standards that have been adopted by the Indian Government. The standards followed by the Indian mobile industry are in compliance to these international standards on radiation with accompanying inherent safety provisions.

Our substantive submissions and concerns on the report/submission are as below:

a. Lower levels of radiation

- i. COAI would like to point out that the report erroneously raises concerns about health effects despite noting at the very outset that EMF radiations from mobile handsets and BTS are found at relatively low end of electromagnetic spectrum and are non-ionizing radiation, i.e. the energy carried by them are unable to break chemical bonds in molecules.
- ii. Based on scientific studies by world reputed organizations, we present that non-ionizing radiation do not cause any genetic damage and that the RF emissions from mobile phones and base stations are thousands of times lower than the levels at which the first health effects begin to be established has been ignored by the Panel.

b. Effect on Human Health

The report has addressed concerns raised about possible health consequences from exposure to the RF fields and thus we have clarified various misconceptions which are reproduced below for your information and ready reference;

- i. **Cancer:** Many studies have been carried out to understand possible link between the radiation emitted from Mobile phones/ Towers and cancer. Interphone study is one of the biggest study conducted till date, on the assessment of the potential risk of glioma and meningioma – two main forms of brain tumor in relation to radiation from mobile. The study included 2708 glioma and 2409 meningioma cases and matched controls was conducted in 13 countries using a common protocol. The much awaited Interphone Study Group published their results in the International Journal of Epidemiology (direct media link), stating that “*Overall, no increase in risk of glioma or meningioma was observed with use of mobile phones.*”

Even the WHO in their letter have further stated that the studies published so far have not provided any evidence an increase in risk of cancer from exposure from low RF fields emitted from mobile towers.

Extract from WHO letter

“Over the past 15 years, studies examining a potential relationship between RF transmitters and cancer have been published. These studies have not provided evidence that RF exposure from the transmitters increases the risk of cancer. **Likewise, long-term animal studies have not established an increased risk of cancer from exposure to RF fields, even at levels that are much higher than produced by base stations and wireless networks”**

- ii. **Skin allergies:** The said report has also alleged that the radiation from the mobile towers has resulted in skin allergies and burns. **Dr A Gnaneshwar Rao**, Head of Department of Dermatology, Gandhi Medical College and Hospital, Hyderabad), explained the effect of radiations in a media works shop that was held in Hyderabad and stated that mobile phones are not carcinogenic. What is important is the sensitivity of people to specific chemical substances used in certain materials that we use regularly. These substances may prove to be allergic and is not related to cell phones. The skin cells have adaptive behaviour in response to electromagnetic radiation. It is unlikely to have deleterious effects on the skin.

c. Effect on honey bees, birds and environment

- i. The United States Department of Agriculture says that there is no link between mobile phones and *Colony Collapse Disorder* CCD. They also quote Stefan Kimmel, the researcher who conducted the German study as saying that there is "*no link between our tiny little study and the CCD-phenomenon ... anything else said or written is a lie.*" Many of the media reports included a statement attributed to Albert Einstein but it is uncertain whether he made the statement. In addition, a 1981 study of bees exposed to 2450MHz signals at much higher powers found no effect on bee behaviour.
- ii. A study conducted in the Netherlands by Guus Van der Poel found that the house sparrow was almost extinct in those urban residential areas, where most houses had been built before 1953. But the bird was found to be thriving in the more recently built areas. His reasoning is that older cities lack sufficient amount of insects. As a result of the extensive building activity of the past 30-40 years, many older towns and city centres have drifted too far away from their former rural surroundings. He concludes that the decline of sparrows in their traditional breeding sites in the urban areas of larger towns is due to the paucity of appropriate food during breeding seasons and suitable nesting venues.
- iii. The British Trust for Ornithology's (BTO) Common Bird Census Programme recorded a 58 per cent decline from 1973 to 1988 across the rural areas of the UK. A BTO nest census reported a 53 per cent decline in both rural and urban areas. Sparrow expert David Summers-Smith, who has been working on sparrows for the last 50 years, records a 95 per cent decline in the urban centres of London, Glasgow, Edinburgh and Dublin. He hypothesises that the decline of the house

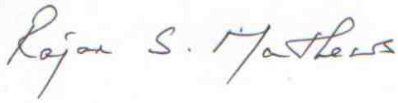
sparrow in London coincides with the increase in traffic and the introduction of unleaded petrol. The new toxic compound (benzene and methyl tertiary butyl ether), that replaced lead in petrol, may be killing insects on which young sparrows depend almost solely for nourishment.

We would also request you to kindly review **COAI position paper on “Mobile RF Radiations and Alleged Health Hazards”** , the same is enclosed as **Annexure – 1** and study the fact sheet by World Health Organization (WHO) enclosed as **Annexure – 2**.

We hope our submissions will merit the kind consideration of the Authority.

Kind Regards,

Sincerely yours,



Rajan S. Mathews
Director General

Encl: as above

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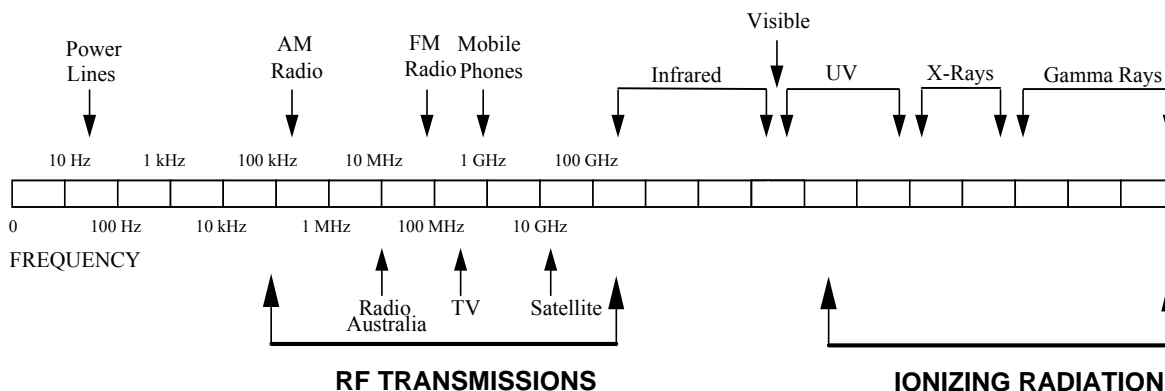
Position Paper – Mobile RF Radiations and Alleged Health Hazards

A. WHAT IS EMF?

Electromagnetic Fields (EMF) occur in nature and thus have always been present on earth. Besides natural sources the electromagnetic spectrum also includes fields generated by human-made sources: X-rays are employed to diagnose a broken limb after a sport accident. The electricity that comes out of every power socket has associated low frequency electromagnetic fields. And various kinds of higher frequency radiowaves are used to transmit information – whether via TV antennas, radio stations or mobile phone base stations.

1. What makes the various forms of electromagnetic fields so different?

One of the main characteristics which defines an electromagnetic field (EMF) is its frequency or its corresponding wavelength. Fields of different frequencies interact with the body in different ways.



2. What is the difference between non-ionizing electromagnetic fields & ionizing radiation?

Wavelength and frequency determine another important characteristic of electromagnetic fields: Electromagnetic waves are carried by particles called quanta. Quanta of higher frequency (shorter wavelength) waves carry more energy than lower frequency (longer wavelength) fields. Some electromagnetic waves carry so much energy per quantum that they have the ability to break bonds between molecules. In the electromagnetic spectrum, gamma rays given off by radioactive materials, cosmic rays and X-rays carry this property and are called 'ionizing radiation'. Fields whose quanta are insufficient to break molecular bonds are called 'non-ionizing radiation'. Man-made sources of electromagnetic fields that form a major part of industrialized life - electricity, microwaves and radiofrequency fields – are found at the relatively long wavelength and low frequency end of the electromagnetic spectrum and their quanta are unable to break chemical bonds.



Some practical information (maximum levels of public exposure) of most common sources of electromagnetic fields. In everyday situations, typical exposures are far below these values.

Source	Typical maximum public exposure	
	Electric field (V/m)	Magnetic flux density (μT)
Natural fields	200	70 (Earth's magnetic field)
Mains power (in homes not close to power lines)	100	0.2
Mains power (beneath large power lines)	10 000	20
Electric trains and trams	300	50
TV and computer screens (at operator position)	10	0.7
	Typical maximum public exposure (W/m^2)	
TV and radio transmitters		0.1
Mobile phone base stations		0.1
Radars		0.2
Microwave ovens		0.5

Source: WHO Regional Office for Europe

It is most important to note that the RF radiations emitted by Mobile Communication Systems lie in the **non-ionizing part of the electromagnetic spectrum and thus do not have enough energy to break the bonds that hold molecules in the cells together.** Thus, the exposure to EMF Radiations emitted from Mobile Systems cannot produce ionization **or cause any genetic damage.**

Also, the RF emissions from mobile phones and base stations are some **50,000 times lower than the levels at which the first health effects begin to be established.** The output power of mobile phones is **less than 1 Watt (typically is in the range of 0.2 to 0.6 watts),** which is **far lower than the emission levels that emanate from the microwave or even the radio.**

B. INTERNATIONAL SAFETY GUIDELINES

International safety guidelines for RF exposure were developed by the **International Commission on Non-Ionizing Radiation Protection (ICNIRP)** and published in 1998.¹ These guidelines have been widely adopted internationally and turned into national safety standards. They apply to mobile phones as well as base stations and incorporate wide safety margins to protect against all established health effects of RF exposure.

These guidelines form the basis for the recommended human RF exposure standards in the European Union², Australia³, much of Asia and Africa.⁴ ICNIRP is a non-governmental organisation formally recognised by the WHO. The guidelines were developed following reviews of all the peer-reviewed scientific literature, including thermal and non-thermal effects. The standards are based on evaluations of biological effects that have been established to have health consequences.

The main conclusion from the WHO reviews is that EMF exposures below the limits recommended in the ICNIRP international guidelines do not appear to have any known consequence on health.

The reference levels for occupational exposure and exposure of the general public are as under;

Type of exposure	Frequency range	Electric field strength (V/m)	Magnetic field strength (A/m)	Equivalent plane wave power density S_{eq} (W/m ²)
General public	Up to 1 Hz	–	2×10^4	–
	1-8 Hz	10 000	$2 \times 10^4/f^2$	–
	8-25 Hz	10 000	$5\ 000/f$	–
	0.025-0.8 kHz	$250/f$	$4/f$	–
	0.8-3 kHz	$250/f$	5	–
	3-150 kHz	87	5	–
	0.15-1 MHz	87	$0.73/f$	–
	1-10 MHz	$87f^{1/2}$	$0.73/f$	–
	10-400 MHz	28	0.073	2
	400-2000 MHz	$1.375f^{1/2}$	$0.0037f^{1/2}$	$f/200$
2-300 GHz	61	0.16	10	

In 1995, Dr Michael Repacholi commented in a report prepared by him as the then Chairman of **International Commission on Non-Ionizing Radiation Protection (ICNIRP)**:

¹ ICNIRP, *Guidelines For Limiting Exposure To Time-Varying Electric, Magnetic, And Electromagnetic Fields (Up to 300 GHz)*, Health Physics, 74(4):494-522, April 1998.

² Council Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (1999/519/EC), Official Journal of the European Communities, 30 July 1999, L199/59-70.

³ ARPANSA, *Radiation Protection Standard – Maximum Exposure Levels to Radiofrequency Fields – 3 kHz to 300 GHz*, 7 May 2002.

⁴ World Health Organization *EMF World Wide Standards Database* accessed at <http://www.who.int/peh-emf/standards/en/> on 01 October 2004.



*“In the case of radio frequency, studies have continued for some 40 years and laboratory techniques are extremely sensitive. While it cannot be dismissed that subtle effects will be found in the future, it is comforting to know that a large amount of research has been conducted and international standards have not had to be lowered for more than fifteen years. **Another point that needs to be remembered is that RF emissions from base stations are some 50,000 times lower than the levels at which the first health effects begin to be established.**”*

Review of ICNIRP Guidelines

In July 2009, ICNIRP reviewed its guidelines in view of the important studies published, that needed detailed analysis and discussion to determine their implications for health. The review aims at providing input to the respective health risk assessment undertaken by the World Health Organization. Together with the review of the scientific evidence in the ELF range. They have published two review papers, one addressing epidemiological evidence related to mobile phones and one reviewing evidence for the full radio-frequency (RF) spectrum.

The first paper, authorized by the ICNIRP Standing Committee on Epidemiology concludes as follows:

'...Overall the studies published to date do not demonstrate an increased risk within approximately 10 years of use for any tumor of the brain or any other head tumor. The available data do not suggest a causal association between mobile phone use and fast-growing tumors such as malignant glioma in adults (at least for tumors with short induction periods)...For slow-growing tumors...the absence of association reported thus far is less conclusive because the observation period has been too short.'

The second report on RF review prepared as an input to the WHO EMF project concludes as below:

- *'...the plausibility of various non-thermal mechanisms that have been proposed is very low.'*
- *'...recent in vitro and animal genotoxicity and carcinogenicity studies are rather consistent overall and indicate that such effects are unlikely at SAR levels up to 4 W kg-1.'*
- *subjective symptoms '...are not causally related to EMF exposure.'*
- *A wide range of subjective symptoms including headaches and migraine, fatigue, and skin itches have been attributed to various RF sources both at home and at work.*
- ***However, the evidence from doubleblind provocation studies suggests that the reported symptoms are not causally related to EMF exposure.***
- *'The experimental data do not suggest so far that children are more susceptible than adults to RF radiation, but few relevant studies have been conducted.'*

C. ADOPTION OF ICNIRP GUIDELINES FOR TELECOM SECTOR IN INDIA TO ENSURE RADIATION LEVELS ARE WITHIN PERMISSIBLE LIMITS

Government of India has already taken necessary safety measures and has adopted the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines for telecom sector in India regarding basic restrictions and reference levels for limiting EMF exposure and the same have also been incorporated into the licenses of the operators. The basic restrictions/ proper limits for power density specified in ICNIRP guidelines for frequencies between 400 to 2000 MHz are as follows.

Type of Exposure	900MHz(inW/m ²)	1800MHz (in W/m ²)
Occupational	22.5	45
General Public	4.5	9

1. Certification for compliance with The ICNIRP Guidelines

On November 4, 2008, DoT made following amendment in the license with regards to the implementation of ICNIRP guidelines regarding the emission by Base Transceiver Stations (BTSs) as below:

“Licensee shall conduct audit and provide self certificates annually as per procedure prescribed by Telecommunication Engineering Centre (TEC)/or any other agency authorized by Licensor from time to time for confirming to limits/levels for antennae (Base Station Emissions) for general public exposure as prescribed by International Commission on Non-Ionizing Radiation Protection (ICNIRP) from time to time”.

Operators are fully conscious of their obligations on this issue and are in process of conducting audits and providing certificates to the Licensor regarding meeting of these standards for Base Station antennae.

2. Emission Measurement Study by Independent Bodies In India

The Industry associations recently commissioned an independent study **to carry out measurement of emissions from** over 300 locations in Delhi, Mumbai and Pune. The study was carried out by, **Indian Institute of Technology Madras, Chennai (IITM), (2) Thiagarajar College of Engineering, Madurai (TCE) and (3) Centre of Excellence in Wireless Technology, Chennai (CEWIT).**

The measurements of the cumulative emissions were meticulously carried out at various locations in Delhi, Mumbai and Pune area by the team of Independent experts using carefully calibrated equipment. While carrying out the measurements, the guide lines as per ICNIRP were followed. The measurements were done for 800 to 2000MHZ band of frequency (which



includes both GSM and CDMA technologies). It was observed that in all locations, multiple frequencies from various base stations were present. To deal with multiple frequencies environment, theoretical calculation method as per the guide lines of ICNRIP to assess whether the overall radiation is within the ICNRIP limits were used.

The measurement results showed that all the 300 places in Delhi, Mumbai and Pune, where the measurements were made from 14th July 2010 to 17th July 2010 and 27th October 2010 to 30th October 2010 respectively, were much below the compliance limit of ICNRIP standards.

D. INTERNATIONAL RESEARCH & REVIEWS

1. It is relevant to mention that for several decades extensive RF research has been undertaken by researchers of the highest integrity at organizations like World Health Organization, British Medical Association, Royal Society of Canada, International Commission on Non-Ionizing Radiation Protection, U.K. Independent Expert Group on Mobile Phones, Swedish Radiation Protection Institute, Food And Drug Administration (USA), Australian Radiation Protection and Nuclear Safety Agency, Indian Council for Medical Research etc. **and general consensus of these studies does not demonstrate any substantive link between human health risks and the use of digital mobile phones or living near a base station.**

2. Biological effects are measurable responses to a stimulus or to a change in the environment. These changes are not necessarily harmful to health. For example, moving from inside to outside on a warm day will produce a range of biological effects. Looking at light from a distant star causes a response in the eye due to the very weak visible light (a form of electromagnetic energy). The body has sophisticated mechanisms to adjust to the many and varied influences encountered in the environment. Changes that are irreversible and stress the system for long periods of time may constitute a health hazard. The WHO states:

An adverse health effect causes detectable impairment of the health of the exposed individual or of his or her offspring; a biological effect, on the other hand, may or may not result in an adverse health effect.

It is not disputed that electromagnetic fields above certain levels can trigger biological effects. Experiments with healthy volunteers indicate that short-term exposure at the levels present in the environment or in the home do not cause any apparent detrimental effects. Exposures to higher levels that might be harmful are restricted by national and international guidelines. The current debate is centred on whether long-term low level exposure can evoke biological responses and influence people's well being.

3. Further, many expert panels have reviewed the large body of existing scientific literature and have **consistently concluded that compliance with the existing science based standards is sufficient to protect public health.** These reviews have concluded that for exposures to radiofrequency energy up to levels below the safety limits prescribed by **International Commission on Non-Ionizing Radiation Protection (ICNIRP) and endorsed by WHO**, there is **no substantive or convincing evidence of biological effects that could harm a person's health.**
4. World Health Organization (WHO) after studying the various research papers presented on the alleged harmful effect of electromagnetic effect on human health has concluded that **'...current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields. However, some gaps in knowledge about biological effects exist and need further research. While research continues the WHO has recommended:**
 - *Strict adherence to existing national or international safety standards.*
 - *Simple protective measures, such as barriers around strong electromagnetic field sources where exposure levels may be exceeded.*

- Consultation with local authorities and the public in siting new power lines or mobile phone base stations.
- An effective system of health information and communication among scientists, governments, industry and the public to help raise general awareness of programmes dealing with exposure to electromagnetic fields and reduce any mistrust and fears.

Summarized conclusion of some WHO reviews are as follows:

- i. Recently in May 2010 WHO has updated its factsheet No. 193 titled "Electromagnetic fields and Public health: mobile phones." It concludes: '*...A large number of studies have been performed over the last two decades to assess whether mobile phones pose a potential health risk. To date, no adverse health effects have been established for mobile phone use.*'
- ii. WHO in their recent letter to Municipal Corporation of Delhi (MCD) stated that the studies published so far have not provided any evidence an increase in risk of cancer from exposure from low RF fields emitted from mobile towers.

Relevant Extract from WHO letter

"Over the past 15 years, studies examining a potential relationship between RF transmitters and cancer have been published. These studies have not provided evidence that RF exposure from the transmitters increases the risk of cancer. **Likewise, long-term animal studies have not established an increased risk of cancer from exposure to RF fields, even at levels that are much higher than produced by base stations and wireless networks**"

iii. **WORLD HEALTH ORGANIZATION, 2006**

"Recent surveys have shown that the RF exposures from base stations range from 0.002% to 2% of the levels of international exposure guidelines, depending on a variety of factors such as the proximity to the antenna and the surrounding environment. This is lower or comparable to RF exposures from radio or television broadcast transmitters".

iv. **WORLD HEALTH ORGANIZATION, 2005**

*"To date, all expert reviews on the health effects of exposure to RF fields have reached the same conclusion: There have been **no adverse health consequences established** from exposure to RF fields at levels below the international guidelines on exposure limits published by the International Commission on Non-Ionizing Radiation Protection".*

v. **WORLD HEALTH ORGANIZATION, 2004**

*"Based on a recent in-depth review of the scientific literature, the WHO concluded that **current evidence does not confirm the existence of any health consequences** from exposure to low level electromagnetic fields. However, some gaps in knowledge about biological effects exist and need further research."*

5. Further, the WHO recommends adoption of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) 1998 guidelines and states that these guidelines '...offer protection against all identified hazards of RF energy with large safety margins'

6. The **UK Mobile Telecommunications Health Research (MTHR)** program has recently issued a progress report covering 23 studies that have been completed with many already published in peer reviewed scientific journals. The report states:

'None of the research supported by the Programme and published so far demonstrates that biological or adverse health effects are produced by radiofrequency exposure from mobile phones.'

7. The aforementioned **view has also been taken by the DoT** in its technical opinion dated 25.8.2004, wherein it has been stated :
"As far as DOT is concerned, **we do not have any authentic information** from any study or report **about any health hazard** of mobile phones or from towers installed for the purpose of providing Mobile Telephone Service."

8. Even the **Telecom Regulatory Authority of India**, which is the expert Regulator, has, in its letter dated 15.9.2004 addressed to the Finance Secretary, UT Chandigarh, stated that :

"Regarding Health Hazard: As per the information available with TRAI, there is no definite conclusive study, which confirms that health is adversely affected by radiation emitted by mobile phones."

9. Further, the Committee formed by the Government of India under the Chairmanship of Dr. N.K. Ganguly, Director General, Indian Council on Medical Research which included representatives from PGIMER, Chandigarh & AIIMS New Delhi, has also opined as under :-

*"Taking the above mentioned into account, the Committee opined that overall **there is not enough evidence to show direct health hazards** of RF exposures from Mobile Base Stations."*

10. **As stated above, several studies have been carried out internationally** with respect to the effect of Electro Magnetic radiation (EMR) on the environment as also the health concerns. However, **till date there is no conclusive evidence of any health ailment caused due to electromagnetic radiations emitted from mobile base stations.**

Some of the true facts and findings which are the result of extensive research and studies carried out by the expert International Bodies of highest reputation are as below:

a. **EUROPEAN COMMISSION EXPERT GROUP**

*"Overall, the **existing scientific literature** encompassing toxicology, epidemiology and other data relevant to health risk assessment, while providing useful information, **provides no convincing evidence** that the use of radiotelephones or other radio systems, whether analogue or digital, poses a **long-term public health hazard.**"*

b. **BRITISH MEDICAL ASSOCIATION**

*"There are **no definite adverse health effects** from mobile phones or their base stations."*

c. **THE BRITISH MEDICAL ASSOCIATION – (JANUARY – 2005)**

*"Current evidence suggests that it is **unlikely** that the special features of the signals from TETRA mobile terminals and repeaters **pose a hazard to health**".*

d. THE HEALTH COUNCIL OF THE NETHERLANDS

*“The **chance of health problems** occurring among people living and working below base stations as a result of exposure to electromagnetic fields **originating from the antennas is, in the Committee’s opinion, negligible**. The field strengths are always considerably less than the exposure limits.”*

*“On the basis of the present data, the Committee concludes that the **occurrence of health problems** at exposure levels associated with the use of mobile phones **is unlikely**. It is considered virtually impossible that the low field strengths in the vicinity of base stations give rise to changes in cognitive functions.”*

e. THE HEALTH COUNCIL OF THE NETHERLANDS, 2004

*“In conclusion, **there is no convincing scientific data** to assume a difference in the absorption of electromagnetic energy in heads of children and adults, nor is it likely that the electromagnetic sensitivity of children’s head changes significantly after the second year of life. Because of this, the Health Council of Netherlands sees no reason for recommending limiting the use of mobile phones by children.”*

f. SWEDISH RADIATION PROTECTION INSTITUTE

*“In many cases where the general public has shown concern, **radiation intensity has proved to be less than a thousandth of the permitted level**”.*

*“To summarize, **mobile telecommunications base stations do not constitute a risk** regarding radiation protection.”*

g. NORDIC COUNTRIES: DENMARK, FINLAND, ICELAND, NORWAY, SWEDEN, 2004

*“The Nordic authorities agree that **there is no scientific evidence for any adverse health effects** from mobile telecommunication systems, neither from the base stations nor from the handsets, below the basic restrictions and reference values recommended by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). However, certain knowledge gaps exist that justifies more research in this field. There are a number of published reports suggesting that biological effects may occur at exposure levels below the ICNIRP guidelines. These studies need to be reproduced and the scientific progress in these fields of research should be followed carefully. In this context, however, it is important to note that biological effects do not necessarily imply health hazard”.*

h. FRENCH ENVIRONMENT HEALTH AND SAFETY AGENCY (AFSEE)

*“The **strength of radiation received from base stations** beyond a few meters from the base stations is **considerably lower than the strength of radiation from radio and television transmitters**.”*

i. AFSSE STATEMENT ON MOBILE PHONES & HEALTH, 2003

*“The AFSSE notes that the **general analysis of current scientific data** on exposure to base station waves **show no health risk linked to mobile phone base stations**. Given this, the recommendations made are based on the principle of responsiveness in order to take into account the public worries about the siting of macro-cellular base stations”.*



j. **INTERNATIONAL COMMISSION IN NON IONIZING RADIATION PROTECTION (ICNIRP)**

*“Epidemiological studies on exposed workers and the general public have shown **no major health effects associated with typical exposure environments.**”*

k. **ICNIRP GUIDELINES**

*“There is **no substantive evidence that adverse health effects**, including cancer, can occur in people exposed to levels at or below the limits on whole body average SAR recommended by INIRC (IRPA / INIRC 1988) or at or below the ICNIRP limits for localized SAR set out in this document”.*

l. **GSMA WEBSITE**

GSMA Association recognizes the fact that, apprehensions have been raised by the public / communities on siting of cellular antennas. However, these antennas are low powered, with typical signal levels in the community similar to those from broadcast services, such as radio and TV.

*In light of all the research / documents on record by various international agencies, GSMA is of the opinion that “To date expert groups have consistently found **no convincing evidence of a public health hazard from mobile communication services.** However, further research has been recommended”.*

m. **GSM ASSOCIATION, MMF AND THE EUROPEAN COMMISSION, 2006**

*A study of mice exposed to GSM900 and GSM1800 type signals has been published on-line in the journal Bioelectromagnetics and **overall finds no evidence that radio signals increase cancer risk.** The authors state ‘In conclusion, the **present study produced no evidence** that the exposure of male and female B6C3F1 mice to wireless GSM and DCS radio frequency signals at a whole body absorption rate of up to 4.0 W/kg **resulted in any adverse health effect** or had any cumulative influence on the incidence or severity of neoplastic and non-neoplastic background lesions, and thus the **study did not provide any evidence of RF possessing a carcinogenic potential.**’*

This study was co-funded by GSMA, the MMF and the European Commission and will make an important contribution to future health risk assessments by the WHO. It is the first whole of life animal study of radiofrequency (RF) exposures using standard toxicological procedures.

n. **UNITED STATES GENERAL ACCOUNTING OFFICE**

***Scientific research to date does not demonstrate** that the radio frequency energy emitted from mobile phones has **adverse health effects**, but the findings of some studies have raised questions indicating the need for further investigation.*

o. **USA: FOOD AND DRUG ADMINISTRATION, 2005**

*“FDA agrees with the NRPB on its conclusions that **there is no hard evidence of adverse health effects** to the general public from exposure to radio frequency energy while using wireless communications devices. A few studies have suggested low level of radio-frequency energy exposure could accelerate the development of cancer in laboratory animals, however, these studies have failed to be replicated, and the vast majority of studied reports in the scientific literature show no adverse health effect associated with low level of radio frequency energy exposure. With regards to the safety and use of cell phones by children, the scientific evidence does not show a danger to users of wireless communication devices including children”.*



p. NETWORK AND ACADEMIC COMPUTING SERVICE, UNIVERSITY OF CALIFORNIA,

“There is no reason to believe that such towers could constitute a potential health hazard to nearby residents or students.”

q. NETWORK & ACADEMIC COMPUTING SERVICES, UNIVERSITY OF CALIFORNIA, 2005

*“Measurements made near typical cellular and PCS installations, especially those with tower-mounted antennas, have shown that **ground-level power densities are thousands of times less than the FCC’s limits for the safe exposure.** In fact, in order to be exposed to levels at or near the FCC limits for cellular or PCS frequencies an individual would essentially have to remain in the main transmitting beam (at the height of the antenna)”.*

r. THE ROYAL SOCIETY OF CANADA

*Therefore at this point, the **epidemiological evidence to date** is inadequate for a comprehensive evaluation of risk, **and does not support a hypothesis of an association between exposure to radio frequency fields and risk of cancer, reproductive problems, or congenital anomalies.***

To date, no convincing, reproducible data exist to demonstrate the ability of MW/RF field exposure to induce seizures or to worsen an existing seizure disorder in human patients.

Headache and fatigue are non specific complaints. For example, many factors can cause headache. Headache is not an indicator of “brain activity” and in general headaches occur in the absence of structural abnormalities of either the brain or the blood brain barrier. Given the high variability of headache as a symptom, correlating headache with some MW –induced neuro chemical alteration is very difficult. Although there is need to consider the possibility of MW induced symptoms such as headache and fatigue, existing data to do not support the conclusion that MW can induce headaches.

s. ROYAL SOCIETY OF CANADA

*All of the authoritative reviews completed within the last two years have concluded that there is **no clear evidence of adverse health effects associated with RF fields.***

*The British Medical Association (2001), for example, concluded that “whilst there are small physiological effects within the existing guidelines, **there are not definite adverse health effects from mobile phones or their base stations.**”*

t. AUSTRALIAN RADIATION PROTECTION AND NUCLEAR SAFETY AGENCY

*“It can be seen that **exposure levels are less than those from FM radio stations (100 MHz) and significantly less than levels from AM radio stations (1 MHz).**”*

u. AUSTRALIAN RADIATION PROTECTION AND NUCLEAR SAFETY AGENCY

No adverse health effects are expected from continuous exposure to the RF radiation emitted by the antennas on mobile telephone base station towers.

v. **AUSTRALIA: COMMITTEE ON ELECTROMAGNETIC ENERGY PUBLIC HEALTH ISSUES, 2003**

*“The weight of national & international scientific opinion is that **there is no substantiated evidence that exposure to low level RF EME cause adverse health effects**. The view is **backed by every major review panel on the subject** including the Royal Society of Canada (1999), the International Expert Group on Mobile Phones (2000), the French Health General Directorate (2001) and ARPANSA’s RF standard Working Group (2002)”.*

w. **MALAYSIA: COMMUNICATIONS & MULTIMEDIA COMMISSION (2001)**

*“For now, we can conclude that **there is no consistent and convincing scientific evidence of adverse health effects** caused by RF radiation. Meanwhile further ongoing research based on established scientific methods will continue to shed light on our understanding of this important health issue.”*

x. **MALAYSIAN INSTITUTE FOR NUCLEAR TECHNOLOGY RESEARCH (MINT), 2003**

“The findings of this study confirms that the presence of the radio frequency and microwave radiation in public accessible areas around the base stations was indeed very low and comparable to the radiation levels found in places away from the facilities. The levels were generally below 11% of the exposure limit for members of the public. The actual contribution made by the base stations themselves was often less than 0.2% of the limit”.

y. **INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS**

***Present scientific evidence**, as reviewed by standards setting organizations and other expert groups, **does not demonstrate health or safety risks** from cellular and other communications transmitters.*

E. USAGE BY CHILDREN INTERNATIONAL RESEARCH & REVIEWS

1. Lastly, it is most relevant to mention that all of the reviews over the last ten years by expert panels and government agencies looking into the health and safety of mobile communications have agreed that the scientific evidence **does not demonstrate any health risks from the use of mobile phones for children**. These include agencies like WHO, ICNIRP, The Health Council of the Netherlands, Food and Drugs Associations, IEEE and many other international bodies
 - *“In conclusion, there is no convincing scientific data to assume a difference in the absorption of electromagnetic energy in heads of children and adults, nor is it likely that the electromagnetic sensitivity of children’s head changes significantly after the second year of life. Because of this, the Health Council of Netherlands sees no reason for recommending limiting the use of mobile phones by children”*

ICNIRP 1998 Guidelines

- *“The protection system using basic restrictions and reference levels makes the ICNIRP guidelines flexible and applicable to virtually any exposure condition, and any group of population. Therefore, there is no need, or justification, for a special approach to the protection of children.”*

Dr Paolo Vecchia, Chairman ICNIRP (2004)

- *“Therefore, in the opinion of ICNIRP, there is neither need nor any justification for a specific approach to the protection of children or other special groups of the population. Consideration of the peculiar characteristics of different groups enters spontaneously into each step of the process of development of the guidelines”*

Dr Paolo Vecchia, Chairman ICNIRP (2005)

- *“From the scientific point of view, there is no evidence to support the need for a special precautionary approach for children or adults”*

The Health Council of the Netherlands

- *“Selvin et al. (1992) reported no increase in cancer risk among children chronically exposed to radiation from a large microwave transmitter near their homes.”*

IEEE (revised Standard C95.1-2005)

- *“Present scientific evidence does not indicate the need for any special precautions for the use of mobile phones. If individuals are concerned, they might choose to limit their own or their children's RF exposure by limiting the length of calls, or by using "hands-free" devices to keep mobile phones away from the head and body”*

World Health Organisation

- *“The scientific evidence does not show a danger to users of wireless phones, including children and teenagers”*

Food and Drug Administration (FDA)



- *“The current World Health Organization view is that international safety guidelines protect everyone in the population with a large safety factor and so there is no scientific basis to restrict children’s use of phones or the locations of base stations. Mobile communications do provide important safety benefits for parents and children. The GSM Association supports parents making up their own mind about when and if their children should use mobile communication technologies.”*

GSM Association

F. SUMMARY

- It is most important to note that the **RF radiations emitted by Mobile Communication Systems lie in the non-ionizing part of the electromagnetic spectrum** and thus **do not have enough energy to cause any genetic damage**. The RF emissions from mobile phones and base stations are some **50,000 times lower than the levels at which the first health effects begin to be established**. Also, the output power of mobile phones is less than 1 Watt (typically is in the range of 0.2 to 0.6 watts), which is far lower than the emission levels that emanate from the microwave or even the radio.
- For several decades extensive RF research has been undertaken by researchers of the highest integrity at various international organizations and **general consensus of these studies does not demonstrate any substantive link between human health risks and the use of digital mobile phones or living near a base station**.
- Many expert panels have reviewed the large body of existing scientific literature and have consistently concluded that compliance with the existing science based standards is sufficient to protect public health. These reviews have concluded that for exposures to radiofrequency energy up to levels, below the safety limits prescribed by International Commission on Non-Ionizing Radiation Protection (ICNIRP) and endorsed by WHO, **there is no substantive or convincing evidence of biological effects that could harm a person's health, that is, ICNIRP guidelines are reliable safeguards for all segments of the population, including children**.
- All of the reviews over the last ten years by expert panels and government agencies looking into the health and safety of mobile communications have agreed that the scientific evidence **does not demonstrate any health risks from the use of mobile phones for children**. These include agencies like **WHO, ICNIRP, The Health Council of the Netherlands, Food and Drugs Associations, IEEE and many other international bodies**.
- The measurement results of study carried out by, **(1) Indian Institute of Technology Madras, Chennai (IITM), (2) Thiagarajar College of Engineering, Madurai (TCE) and (3) Centre of Excellence in Wireless Technology, Chennai (CEWIT)**, showed that all the 300 places in Delhi, Mumbai and Pune, where the measurements were made from 14th July 2010 to 17th July 2010 and 27th October 2010 to 30th October 2010 respectively, were much below the compliance limit of ICNIRP standards.



Fact sheet N°304
May 2006

Electromagnetic fields and public health

Base stations and wireless technologies

Mobile telephony is now commonplace around the world. This wireless technology relies upon an extensive network of fixed antennas, or base stations, relaying information with radiofrequency (RF) signals. Over 1.4 million base stations exist worldwide and the number is increasing significantly with the introduction of third generation technology.

Other wireless networks that allow high-speed internet access and services, such as wireless local area networks (WLANs), are also increasingly common in homes, offices, and many public areas (airports, schools, residential and urban areas). As the number of base stations and local wireless networks increases, so does the RF exposure of the population. Recent surveys have shown that the RF exposures from base stations range from 0.002% to 2% of the levels of international exposure guidelines, depending on a variety of factors such as the proximity to the antenna and the surrounding environment. This is lower or comparable to RF exposures from radio or television broadcast transmitters.

There has been concern about possible health consequences from exposure to the RF fields produced by wireless technologies. This fact sheet reviews the scientific evidence on the health effects from continuous low-level human exposure to base stations and other local wireless networks.

Health concerns

A common concern about base station and local wireless network antennas relates to the possible long-term health effects that whole-body exposure to the RF signals may have. To date, the only health effect from RF fields identified in scientific reviews has been related to an increase in body temperature ($> 1\text{ }^{\circ}\text{C}$) from exposure at very high field intensity found only in certain industrial facilities, such as RF heaters. The levels of RF exposure from base stations and wireless networks are so low that the temperature increases are insignificant and do not affect human health.

The strength of RF fields is greatest at its source, and diminishes quickly with distance. Access near base station antennas is restricted where RF signals may exceed international exposure limits. Recent surveys have indicated that RF exposures from base stations and wireless technologies in publicly accessible areas (including schools and hospitals) are normally thousands of times below international standards.

In fact, due to their lower frequency, at similar RF exposure levels, the body absorbs up to five times more of the signal from FM radio and television than from base stations. This is because the frequencies used in FM radio (around 100 MHz) and in TV broadcasting (around 300 to 400 MHz) are lower than those employed in mobile telephony (900 MHz and 1800 MHz) and because a person's height makes the body an efficient receiving antenna. Further, radio and television broadcast stations have been in operation for the past 50 or more years without any adverse health consequence being established.

While most radio technologies have used analog signals, modern wireless telecommunications are using digital transmissions. Detailed reviews conducted so far have not revealed any hazard specific to different RF modulations.

Cancer: Media or anecdotal reports of cancer clusters around mobile phone base stations have heightened public concern. It should be noted that geographically, cancers are unevenly distributed among any population. Given the

widespread presence of base stations in the environment, it is expected that possible cancer clusters will occur near base stations merely by chance. Moreover, the reported cancers in these clusters are often a collection of different types of cancer with no common characteristics and hence unlikely to have a common cause.

Scientific evidence on the distribution of cancer in the population can be obtained through carefully planned and executed epidemiological studies. Over the past 15 years, studies examining a potential relationship between RF transmitters and cancer have been published. These studies have not provided evidence that RF exposure from the transmitters increases the risk of cancer. Likewise, long-term animal studies have not established an increased risk of cancer from exposure to RF fields, even at levels that are much higher than produced by base stations and wireless networks.

Other effects: Few studies have investigated general health effects in individuals exposed to RF fields from base stations. This is because of the difficulty in distinguishing possible health effects from the very low signals emitted by base stations from other higher strength RF signals in the environment. Most studies have focused on the RF exposures of mobile phone users. Human and animal studies examining brain wave patterns, cognition and behaviour after exposure to RF fields, such as those generated by mobile phones, have not identified adverse effects. RF exposures used in these studies were about 1000 times higher than those associated with general public exposure from base stations or wireless networks. No consistent evidence of altered sleep or cardiovascular function has been reported.

Some individuals have reported that they experience non-specific symptoms upon exposure to RF fields emitted from base stations and other EMF devices. As recognized in a recent WHO fact sheet "Electromagnetic Hypersensitivity", EMF has not been shown to cause such symptoms. Nonetheless, it is important to recognize the plight of people suffering from these symptoms.

From all evidence accumulated so far, no adverse short- or long-term health effects have been shown to occur from the RF signals produced by base stations. Since wireless networks produce generally lower RF signals than base stations, no adverse health effects are expected from exposure to them.

Protection standards

International exposure guidelines have been developed to provide protection against established effects from RF fields by the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 1998) and the Institute of Electrical and Electronic Engineers (IEEE, 2005).

National authorities should adopt international standards to protect their citizens against adverse levels of RF fields. They should restrict access to areas where exposure limits may be exceeded.

Public perception of risk

Some people perceive risks from RF exposure as likely and even possibly severe. Several reasons for public fear include media announcements of new and unconfirmed scientific studies, leading to a feeling of uncertainty and a perception that there may be unknown or undiscovered hazards. Other factors are aesthetic concerns and a feeling of a lack of control or input to the process of determining the location of new base stations. Experience shows that education programmes as well as effective communications and involvement of the public and other stakeholders at appropriate stages of the decision process before installing RF sources can enhance public confidence and acceptability.

Conclusions

Considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak RF signals from base stations and wireless networks cause adverse health effects.

WHO Initiatives

WHO, through the International EMF Project, has established a programme to monitor the EMF scientific literature, to evaluate the health effects from exposure to EMF in the range from 0 to 300 GHz, to provide advice about possible EMF hazards and to identify suitable mitigation measures. Following extensive international reviews, the International EMF Project has promoted research to fill gaps in knowledge. In response national governments and research institutes have funded over \$250 million on EMF research over the past 10 years.

While no health effects are expected from exposure to RF fields from base stations and wireless networks, research is still being promoted by WHO to determine whether there are any health consequences from the higher RF exposures from mobile phones.

The International Agency for Research on Cancer (IARC), a WHO specialized agency, is expected to conduct a review of cancer risk from RF fields in 2006-2007 and the International EMF Project will then undertake an overall health risk assessment for RF fields in 2007-2008.

Further Reading

[ICNIRP \(1998\) www.icnirp.org/documents/emfgdl.pdf](http://www.icnirp.org/documents/emfgdl.pdf)

IEEE (2006) IEEE C95.1-2005 "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz"

Related links

- [Base stations & wireless networks: Exposures & health consequences](#)
- [Fact sheet: Electromagnetic fields and public health: Electromagnetic Hypersensitivity](#)
- [WHO handbook on "Establishing a Dialogue on Risks from Electromagnetic Fields"](#)
- [2006 WHO Research Agenda for Radio Frequency Fields \[pdf 791kb\]](#)

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Electromagnetic fields and public health: mobile phones

Key facts

- Mobile phone use is ubiquitous with an estimated 4.6 billion subscriptions globally.
- To date, no adverse health effects have been established for mobile phone use.
- Studies are ongoing to assess potential long-term effects of mobile phone use.
- There is an increased risk of road traffic injuries when drivers use mobile phones (either handheld or "hands-free") while driving.

Mobile or cellular phones are now an integral part of modern telecommunications. In many countries, over half the population use mobile phones and the market is growing rapidly. At the end of 2009, there were an estimated 4.6 billion subscriptions globally. In some parts of the world, mobile phones are the most reliable or the only phones available.

Given the large number of mobile phone users, it is important to investigate, understand and monitor any potential public health impact.

Mobile phones communicate by transmitting radio waves through a network of fixed antennas called base stations. Radiofrequency waves are electromagnetic fields, and unlike ionizing radiation such as X-rays or gamma rays, cannot break chemical bonds nor cause ionization in the human body.

Exposure levels

Mobile phones are low-powered radiofrequency transmitters, operating at frequencies between 450 and 2700 MHz with peak powers in the range of 0.1 to 2 watts. The handset only transmits power when it is turned on. The power (and hence the radiofrequency exposure to a user) falls off rapidly with increasing distance from the handset. A person using a mobile phone 30–40 cm away from their body – for example when text messaging, accessing the internet, or using a “hands free” device – will therefore have a much lower exposure to radiofrequency fields than someone holding the handset against their head.

In addition to using "hands-free" devices, which keep mobile phones away from the head and body during phone calls, exposure is also reduced by limiting the number and length of calls. Using the phone in areas of good reception also decreases exposure as it allows the phone to transmit at reduced power. The use of commercial devices for reducing radiofrequency field exposure has not been shown to be effective.

Mobile phones are often prohibited in hospitals and on airplanes, as the radiofrequency signals may interfere with certain electro-medical devices and navigation systems.

Are there any health effects?

A large number of studies have been performed over the last two decades to assess whether mobile phones pose a potential health risk. To date, no adverse health effects have been established for mobile phone use.

Short-term effects

Tissue heating is the principal mechanism of interaction between radiofrequency energy and the human body. At the frequencies used by mobile phones, most of the energy is absorbed by the skin and other superficial tissues, resulting in negligible temperature rise in the brain or any other organs of the body.

A number of studies have investigated the effects of radiofrequency fields on brain electrical activity, cognitive function, sleep, heart rate and blood pressure in volunteers. To date, research does not suggest any consistent evidence of adverse health effects from exposure to radiofrequency fields at levels below those that cause tissue heating. Further, research has not been able to provide support for a causal relationship between exposure to electromagnetic fields and self-reported symptoms, or "electromagnetic hypersensitivity".

In contrast, research has clearly shown an increased risk of road traffic injuries when drivers use mobile phones (either handheld or "hands-free") while driving. In several countries, motorists are prohibited or strongly discouraged from using mobile phones while driving.

Long-term effects

Epidemiological research examining potential long-term risks from radiofrequency exposure has mostly looked for an association between brain tumours and mobile phone use. However, because many cancers are not detectable until many years after the interactions that led to the tumour, and since mobile phones were not widely used until the early 1990s, epidemiological studies at present can only assess those cancers that become evident within shorter time periods. However, results of animal studies consistently show no increased cancer risk for long-term exposure to radiofrequency fields.

Several large multinational epidemiological studies have been completed or are ongoing, including case-control studies and prospective cohort studies examining a number of health endpoints in adults. To date, results of epidemiological studies provide no consistent evidence of a causal relationship between radiofrequency exposure and any adverse health effect. Yet, these studies have too many limitations to completely rule out an association.

A retrospective case-control study on adults, INTERPHONE, coordinated by the International Agency for Research on Cancer (IARC), was designed to determine whether there are links between use of mobile phones and head and neck cancers in adults. The international pooled analysis of data gathered from 13 participating countries found no increased risk of glioma or meningioma with mobile phone use of more than 10 years. There are some indications of an increased risk of glioma for those who reported the highest 10% of cumulative hours of cell phone use, although there was no consistent trend of increasing risk with greater duration of use. Researchers concluded that biases and errors limit the strength of these conclusions and prevent a causal interpretation.

While an increased risk of brain tumors is not established from MOBILEPHONE data, the increasing use of mobile phones and the lack of data for mobile phone use over time periods longer than 15 years warrant further research of mobile phone use and brain cancer risk. In particular, with the recent popularity of mobile phone use among younger people, and therefore a potentially longer lifetime of exposure, WHO has promoted further research on this group. Several studies investigating potential health effects in children and adolescents are underway.

Exposure limit guidelines

Radiofrequency exposure limits for mobile phone users are given in terms of Specific Absorption Rate (SAR) – the rate of radiofrequency energy absorption per unit mass of the body. Currently, two international bodies^{1 2} have developed exposure guidelines for workers and for the general public, except patients undergoing medical diagnosis or treatment. These guidelines are based on a detailed assessment of the available scientific evidence.

WHO'S response

In response to public and governmental concern, WHO established the International Electromagnetic Fields (EMF) Project in 1996 to assess the scientific evidence of possible adverse health effects from electromagnetic fields. WHO will conduct a formal health risk assessment of radiofrequency fields exposure by 2012. Meanwhile, the International Agency for Research on Cancer (IARC), a WHO specialized agency, is expected to review the carcinogenic potential of mobile phones in 2011.

WHO also identifies and promotes research priorities for radiofrequency fields and health to fill gaps in knowledge through its Research Agenda.

WHO develops public information materials and promotes dialogue among scientists, governments, industry and the public to raise the level of understanding about potential adverse health risks of mobile phones.

¹ International Commission on Non-Ionizing Radiation Protection – ICNIRP. Statement on the "Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)", 2009.

² Institute of Electrical and Electronics Engineers IEEE Std C95.1 – 2005. *IEEE standard for safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz.*

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