

Executive Summary

The aim of this report was to produce an independent critical review of the recent literature on the possible biological and health effects of low-intensity, high-frequency electromagnetic fields, from the viewpoint of the region's scientists and experts. Examples of these electromagnetic fields, which are called radiofrequency (RF) fields, are those used for radio and TV communication, mobile voice and data communication and wireless data networks. Special emphasis was to be placed on the results of studies conducted in Latin American countries. International and national exposure limits, policies and standards are also examined in this respect.

Biological and Health Effects

The first and most important part of the the literature review examined the scientific evidence for possible biological and health effects of RF. The two known actions of RF fields on living matter are assessed: thermal (due to dielectric heating of molecules); and non-thermal (mechanisms not due to local or whole body increases in temperature). The first part of the review examines experimental evidence based both on *in vitro* (cell cultures and isolated tissues) and *in vivo* (living animals) models. The second part reviews the literature on RF effects on human performance and health parameters, both from the point of view of laboratory (provocation) studies, as well as by means of observational (epidemiological) studies. This review has concentrated on exposure of humans to RF levels compatible with base stations (so called community exposures) or during the individual operation of mobile phone handsets close to the body.

Experimental Studies

The general conclusion of *in vitro* studies is that there is, so far, inadequate evidence or a lack of consistent and validated evidence to establish my cause-effect relationship between exposure to low level RF and short-term effects on cell cycle and regulation, membrane transport, apoptosis, genotoxicity, mutation rates, gene and protein expression, damage to genetic material and cell proliferation, transformation and differentiation of cells and tissues. Some reported effects that have been established appear to have little significance on cancer or impact on larger cell systems, at least when RF exposures are kept below recommended safety levels, even for long periods of time. Thus, there is very little plausibility for effects at the cellular level that might lead damage at the higher organ levels or for human health consequences.

In regard to *in vivo* animal studies, one of the most significant RF effects to be reported is disruption of the blood-brain barrier (BBB). This was reported in small laboratory animals in less than 30% of reviewed studies. However, most well controlled studies have not reported these effects and it seems that the positive results could be explained more simply by uncontrolled effects of heating. Further, the translation of such results to human beings, with entirely different cranial geometries and blood flow, is very doubtful.

The induction and promotion of tumors or blood neoplasms by RF exposure in animals as well as the appearance of cellular molecular predecessors of tumorigenesis, etc. has also been investigated. Despite using RF exposures, measured as specific absorption rates (SARs), far above those that people are normally exposed to, and in some cases exposures for the duration of the animal's lifetime, about 93% of *in vivo* studies published since 1990 have shown no significant short or long-term effects. Further, the average survival of irradiated groups of animals was not affected in some 96% of studies.

No convincing evidence has been presented for RF acute or chronic effects of RF on other physiological and biochemical parameters in animals. Thus, the general conclusion, after more than 20 years of *in vivo* studies, is that no consistent or important effects of RF could be demonstrated in intact animals below international safety standards. There seems to be no important pathophysiological effect of RF fields, apart from thermal effects caused by exposure to fields many times larger than those encountered in our living and working environments.

Human provocation studies have investigated mostly possible effect on the nervous system, including many cognitive and behavioral responses, in response to low-level RF fields emitted by mobile telephones near children as well as in adults. It is now generally accepted that there are no significant effects of cell phone usage or reasonable proximity to radiating antennas of base stations on them. Other investigated effects on pain, vision, hearing and vestibular function, as well as on the endocrine and cardiovascular systems, were mostly negative. Taste and olfaction have not been studied, so far. Even in studies that reported a mild effect, they were not considered as detrimental to health. However, their significance from long-term exposure could not be verified. Studies using functional imaging of the brain and deep infrared thermography have shown that there is no significant heating caused directly by RF exposure in the bone or brain.

In the so-called "**RF hypersensitivity symptoms**", 4 to 5% of the population report being sensitive to RF fields, while some of these intolerant individuals report ill health and a number of distressing subjective symptoms during and after using a cell phone and from exposure to other radiofrequency-emitting devices, or being near an RF antenna site. These symptoms are quite nonspecific and are present in many diseases, such as cold and flu-like symptoms (headache, nausea, fatigue, muscle aches, malaise, etc.). However, several studies, systematic reviews and meta-analyses in the last 15 years have concluded that hypersensitivity and the observed symptoms have no correlation to RF exposure of individuals. There is presently no scientific basis for characterizing RF hypersensitivity as a medical syndrome.

One can conclude from human experimental studies that current science-based evidence points to there being no adverse effects in humans below thermal thresholds, no hazardous influences on the well-being and health status of users and non-users of cell phones and people living near base stations, and that no convincing evidence for adverse cognitive, behavioral and neurophysiological and other physiological effects exist.

Epidemiological Studies

With regard to community exposures from base stations antennas, there is a scientific consensus that these levels are many thousands of times below the international safety standards, even at short distances from the antennas. The few published epidemiological studies with a minimally accepted degree of quality have not demonstrated any clear

effects of RF exposure on morbidity, mortality, effects on well-being and health status of population groups living near the RF sources. Long duration studies are lacking, however. Furthermore, it is difficult to separate exposures to cell phone base stations from those of other sources, such as radio and TV broadcasts, with any degree of accuracy.

On the other hand, a much larger number of epidemiological studies investigating possible effects of RF exposure of cell phone handset users have been published. Many of them have a good methodological quality and a large number of subjects. While some large cohort studies have not detected any higher risks for users of cell phones for a period up to 15 years when compared to non-users, for a number of outcomes, including malignant and benign tumors of the nervous system; a small number of restricted epidemiological studies have contradicted these results for some tumors, among heavy and long time users, in the most used side of the head. Larger and better controlled studies, such as INTERPHONE (an international collaborative study which has involved 16 careful case/control studies in 13 different countries), generally reported a lack of statistical associations, except for a disputable slighter higher risk of gliomas and acoustic neuromas for users with more than 10 years of use. No epidemiological studies with long term exposures larger than 20 years have been published so far, as well as no study addressing health risks of cell phone usage by children and adolescents.

Epidemiological studies of associations between exposure of populations to RF of cell phones or base stations and several other health problems, such as neurodegenerative disorders, cardiovascular diseases, cataracts, reproductive health changes, behavioral changes and nonspecific symptoms, etc. have resulted in mostly statistically non-significant associations.

In addition, there is a large number of methodological difficulties in epidemiological studies of exposure to low-level RF, including several kinds of biases which are hard to identify and compensate for.

We conclude, therefore, that current published RF epidemiological studies have not shown any sizable, incontrovertible and reproducible adverse health effect, and that numerous methodological flaws, along with only the few outcomes examined so far, do not allow for firm conclusions, particularly as it relates to children and to continuous exposure for periods larger than 20 years.

Indirect Effects

The possibility that medical devices could interfere or be adversely affected by RF emitted by the antennas of base stations and portable wireless devices in their proximity has prompted, in the 1990s, many engineering and clinical tests around the world. This might be one of the few documented, albeit indirect detrimental effects of low level RF fields on the health of exposed people. This is especially the case for patients using implanted cardiac pacemakers or defibrillators, or hooked up to life support devices, such as mechanical ventilators, which are vital for their continued survival.

Our review of this subject concluded that wireless communication technologies with enough output power and very close proximity to medical devices of several kinds, including implanted devices, have the possibility of causing electromagnetic interference with potential hazardous effects on the well being and critical life support of patients. However, the low power technologies and frequency spectrum used by present-day digital

communications devices and the electronic filters installed on modern medical devices have greatly reduced the chance of occurrence of such hazards, when they are used normally. Thus, scientifically and technically there is presently no need to restrict the use of medium risk mobile phones and wireless data communication devices in any area of healthcare institutions, and no general ban policy is necessary, or legislation to this effect. Higher powered communication radios and data communication modems, which may pose a higher risk of interference, should be used sparingly and in emergency situations only if they are very near to medical devices, implanted or not.

Another kind of indirect effect of cell phones and other portable voice and data communication media is the risk posed by using them while driving a motor vehicle. Since this risk does not relate to an effect of RF fields, it has not been examined by the review.

Social Issues and Public Communication

A lack of good risk communication and understanding of the public's perception and acceptance of risk seem to be a major contributor to the fear about possible health effects from mobile communications technology. Also important is the public's understanding of science.

Fear of technology is not novel. There has been fear of detrimental health effects when telegraph wires, TV sets, power transmission lines, aspartame, silicone breast implants, and many others were first introduced. Also, EMFs are not perceptible to our senses, adding to the public's concern.

An obvious way to alleviate this fear and anxiety about possible RF effects is to provide people with as much information as possible (user education), provided such information is well proven and provided by qualified experts and organizations. Every effort must be made not to increase peoples' concerns. For example, discussing scientific uncertainty and implementing precautionary measures may have a negative impact on the public's perception of risk or its trust in policies and government agencies if not done with care.

An important factor for public acceptance of new technologies seems to be risk/benefit comparison, which is not obvious. Of particular interest to mobile phone users, industry and government is the fact that there have been few recent studies on risks versus benefits for mobile communications, compared to many other technologies that have a strong impact on society.

Despite the existence of an overwhelming body of serious research demonstrating no confirmed detrimental health effects from RF, with the exception of using a mobile phone while driving, alarmist media reports have created a public view that is out-of-step with the scientific evidence.

All technologies have their share of risks. These must be counterbalanced by a careful study of its benefits. Such is the case of automobiles, airplanes, chemicals used in agriculture, food conservation, oil and coal combustion, nuclear power, genetically modified foodstuffs, etc. Society has recognized and accepted all of them, due to their extreme usefulness provided the risks are managed by enforcing exposure limits, making technological modifications, or similar measures to reduce risks. Thus, there is a need for more studies focusing on the social and economical benefits of mobile communication

technologies.

This section covers the report on social research and communication to the public, and addresses several interrelated topics, such as risk perception, risk acceptance and risk/benefit issues, social resistance to new technologies, the understanding benefits: perceived and real impacts of mobile communication on health, well-being and security of the public, public understanding of science. public communication on EMF and health issue, communicating about uncertainties in science. applying and communicating the precautionary measures, evaluating the quality of information to the public and ethical and professional responsibility of the mass media.

Latin American references on public communication and social research on EMF are scarce. Most of this review was based on references from country reports in Europe, the USA or other non-Latin American countries.

It is suggested there should be a reference location for the Latin American region providing Internet coverage of all relevant issues related to EMF and Health. It should be located either in the appropriate government regulatory agency or in a prestigious university or research institute.

Having many different rules only creates confusion and mistrust of government. Every effort should be made to harmonize standards at all levels (from national to state or municipality level) adopting science-based standards recommended by international bodies such as ICNIRP.

Non-Ionizing Radiation Protection Standards and Policies

In the last third of the 20th century, concern about possible detrimental effects on human health of artificial non-ionizing electromagnetic radiation (NIR) prompted many efforts to determine the maximum levels of exposure and to set up recommendations for safety standards for the entire EMF spectrum, both for occupational and for the general public. These standards of safety are based on evidence provided by scientific studies worldwide, and are revised periodically. In addition, the World Health Organization's International Electromagnetic Fields (EMF) Project has been promoting the adoption of science-based international standards and the harmonization of national standards. As important tools to achieve these commitments, WHO has compiled a worldwide standards database and has published two policy handbooks that are very useful for countries developing NIR standards.

The purpose of the chapter is to provide information on standards and policies in Latin American countries in order to inform government and other authorities about policies and regulations in the region and about international standards recommended by WHO. The structure of several standards and recommendations are examined, such as those developed by the International Commission on Non- Ionizing Radiation Protection (ICNIRP), the IEEE (Institute of Electrical and Electronic Engineering), the ITU (International Telecommunications Union) and the USA FCC (Federal Communications Committee).

After 1992 the ICNIRP has been charged with the development and maintenance of international guidelines for NIR. Its 1998 publication established general public and occupational maximum permissible limits against NIR exposure and are the most credible international guidelines on NIR, being endorsed by WHO, the International Labor Office

(ILO) and the International Telecommunications Union (ITU). By 2009 they had been adopted as national standards by more than 50 countries worldwide. The IEEE standards adopted in North America are similar, but less strict than the ICNIRP Guidelines although they are based on the same science.

The ITU has made recommendations on compliance of telecommunication systems with EMF exposure limits. At the regional level in Latin America the Inter-American Telecommunication Commission (CITEL) has compiled information and regulations of the WHO, the Pan American Health Organization (PAHO), the ITU, the ICNIRP, the Mobile Manufacturers Forum (MMF), the International Electrotechnical Commission (IEC), with respect to the effects of NIR and the established technical standards. CITEL has also compiled EMF regulations in force in Latin America and other regions.

Currently in Latin America there are 10 countries that have implemented non-ionizing radiation standards for telecommunication systems: Argentina, Bolivia, Brazil, Colombia, Chile, Ecuador, Panama, Paraguay, Peru and Venezuela. Others are being developed, such as Costa Rica, Dominican Republic and Uruguay. Most of the implemented standards are based on ICNIRP guidelines.