Exposure of farm workers to electromagnetic radiation from cellular network radio base stations situated on rural agricultural land

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The electromagnetic field (EMF) levels generated by mobile telephone radio base stations (RBS) situated on rural-agricultural lands were assessed in order to evaluate the exposure of farm workers in the surrounding area. The expected EMF at various distances from a mobile telephone RBS was calculated using an *ad hoc* numerical forecast model. Subsequently, the electric fields around some RBS on agricultural lands were measured, in order to obtain a good approximation of the effective conditions at the investigated sites. The viability of this study was tested according to the Italian Regulations concerning general and occupational public exposure to time-varying EMFs. The calculated E-field values were obtained with the RBS working constantly at full power, but during the *in situ* measurements the actual power emitted by RBS antennas was lower than the maximum level, and the E-field values actually registered were much lower than the calculated values.

Keywords: electromagnetic field; cellular network; workers' exposure

1. Introduction

In 1998, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) established two sets of regulations to provide suitable protection from exposure to time-varying electric, magnetic and electromagnetic fields (EMF). The first set of regulations related to general public exposure and the second set was connected with occupational exposure.[1] The general public is unaware of exposure to EMF, whereas occupationally exposed workers are adults who are generally exposed in known conditions, informed of potential risks and trained to take suitable precautions. For these reasons, the legal exposure levels are usually much higher for exposed workers than for the general public.

These exposure limits were founded on basic restrictions and reference levels. Basic restrictions were based directly on established short-term health effects, and developed for various frequency ranges to prevent adverse effects on the nervous system and thermal effects. Long-term effects were not assessed, because not enough data was available upon which to base exposure restrictions.

The basic restrictions established maximum limits which must not be exceeded in order to ensure protection. Reference levels of exposure are set for comparison with measured values of physical quantities, and agreement with all reference levels assures compliance with the basic restrictions.

According to these recommendations, Directive 2004/ 40 [2] established the minimum health and safety requirements regarding exposure of workers to EMF; it used the same ICNIRP threshold values but gave them different names. Basic restrictions became limit values and reference levels became action values. The deadline for EU Member States to convert Directive 2004/40 into national legislation was postponed from April 30, 2008 to April 30, 2012 by successive Directive 2008/46, and Directive 2012/11 extended the deadline to October 31, 2013.

The most recent Directive 2013/35 repealed Directive 2004/40 and the deadline is now July 1, 2016.[3] This new Directive assesses exposure limit values (ELV), which are equivalent to ICNIRP's basic restrictions, and action levels (AL), which are equivalent to ICNIRP's reference levels. Furthermore, there are two sets of each value: health ELV and corresponding high AL, and sensory ELV and corresponding low AL.[3]

In 1999, the European Council issued Recommendations for limiting exposure of the general public to EMF [4] in accordance with these ICNIRP guidelines.

Directive 2013/35 has not yet been incorporated into the Italian legislation regarding workplace health and safety;[5] the provisions of Directive 2004/40 have been implemented, but will come into force at the new deadline. Therefore, the compulsory minimum health and safety requirements concerning the exposure of workers to EMF,

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that is Limit and Action Values, are not yet in force in Italy. However, this delay is related only to the provisions for limit and action values; in reality Italian law obliges employers to analyse the EMF risks as part of their evaluation of the risks to which their workers may be exposed.

In contrast, the European Council Recommendation was implemented in a 2003 Italian Prime Ministerial decree; this is still in force, and concerns EMF exposure of the general public to the frequency range 100–300 GHz.[6] This Regulation provides the following threshold values: exposure limits must not be exceeded, and attention values are based on precautionary measures against possible long-term effects of EMF exposure greater than 4 h per day. In Italy, therefore, all evaluation of EMF exposure for both the general and occupational public is carried out in order to check on compliance with these restrictions.

In recent years, the rapid spread of mobile telephone technology (audio-video communications, data transmission, etc.) has greatly increased the number of signal transmission sites in Italy; these radio base stations (RBS) allow the use of mobile communication devices via signal irradiation.

Signal irradiation is obtained by using electromag-netic waves in which electric and magnetic fields vary periodically in time, permitting energy transmission.[7]

The RBS for mobile telephones are often situated on agricultural land, where farm workers may spend several hours of working days without taking any precautions against EMF exposure.

A human body inside an EMF interacts with it, generating a physical coupling between its biological system and the field. This coupling produces an induced elec-tric field, an induced magnetic field and a significant and non-uniform local energy absorption for the typical frequencies (890–960 MHz; 1710–1880 MHz) used by the mobile telephone sector.[8,9] The physical coupling processes between EMF and biological systems are strictly related to the geometry of the human body, to tissue proper-ties and to exposure conditions. In addition, the frequency of the EMF profoundly affects these coupling processes, so that the limit values are related to the frequency.[10–12]

Starting with these considerations, we analysed the EMF levels generated by mobile telephone RBS situ-ated on rural-agricultural lands in order to evaluate the exposure of farm workers in the surrounding area, especially those involved in open-field vegetable production or working inside confined environments (i.e., greenhouses and tunnels).[13] These workers are generally unaware of their exposure to EMF; they are not informed about the potential risks and, because they do not take any suitable precautions, they are considered as the general public.

In order to estimate the expected EMF at various distances from a mobile telephone RBS, we used an *ad hoc* numerical forecast model with technical characteristics similar to those used by the different telephone operators.

Table 1. Basic restrictions for general public exposure to time-varying electromagnetic field for frequency range relating mobile telephony radio base station.

Whole-body average SAR (W kg^{-1})	Localized SAR (head and trunk) (W kg^{-1})	Localized SAR (limbs) (W kg^{-1})
0.08	2	4

Note: SAR = specific absorption rate.

Table 2. Reference levels for general public exposure to time-varying electromagnetic field for frequency range relating mobile telephony radio base station.

E-field strength (V m^{-1})	H-field strength (A m^{-1})
41	0.11

Subsequently, we measured electric fields around some RBS on agricultural lands, in order to obtain a good approximation of the effective conditions at the investigated sites and to compare the experimental values with the predicted values.

The feasibility of this study focusing on assessment of agricultural workers' exposure to RBS-produced EMF was tested in compliance with the Italian legal limits on the operating frequencies of mobile telephone RBS. These are as follows for electric-field (E-field) strength E and magnetic-field (H-field) strength H: exposure limits of $E = 20.0$ V m^{-1} and $H = 0.05$ A.m^{-1}; attention values of $E = 6.0$ V m^{-1} and $H = 0.016$ A m^{-1}.

In order to compare these values, Tables 1 and 2 report the ICNIRP's basic restrictions and reference levels for exposure of the general public in the frequency range of mobile telephone RBSs. The basic restrictions (Table 1) are provided on specific absorption rate (SAR), whereas the reference levels (Table 2) are calculated on the lowest frequency used by mobile telephone RBSs (890 MHz). In addition, the ICNIRP guidelines stipulate that the E-field averaged over 6 min must be considered for EMF exposure, and not the peak values.

Comparison of the attention values and the reference levels shows that Italian limits are much lower than the limits in the ICNIRP guidelines.

2. Materials and methods

2.1. Theoretical considerations

Mobile phone RBS aerials usually consist of a set of vertical radiating elements with a reflective back shield; the radiation pattern is not symmetrical but has a main radiation lobe with a narrow vertical width (5°–15°, at −3 dB) and a wider horizontal width (60°–90°, at −3 dB).

An EMF modifies its characteristics according to the distance from the source of radiation, therefore the field surrounding the antenna was divided into three principle

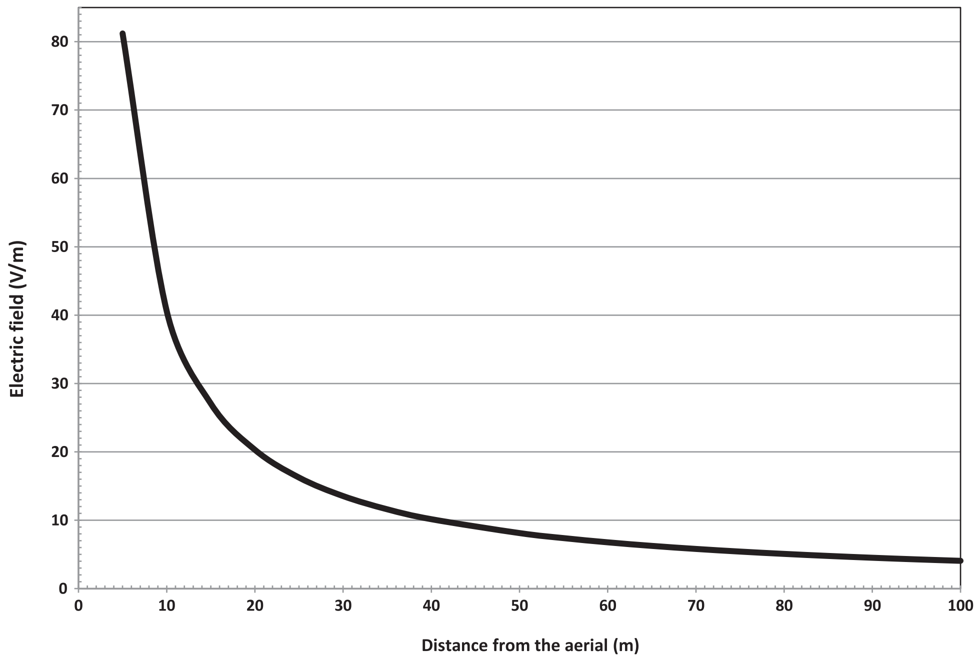

Figure 1. E-field in the direction of the highest radiation of the aerial (transmitter 100 W, gain 17.4 dB_i).

areas: (a) reactive near field; (b) radiating near field, known as the Fresnel region; and (c) far field, known as the Fraunhofer region which extends to infinity. Furthermore, when evaluating the field strength produced by a source, it is necessary to consider the contribution of other prospective nearby sources. For the aims of this work, the far field of the radiated EMF was analysed.

The radiation pattern does not change shape with distance (although the fields still die off as *1/r* and the power density dies off as $1/r^2$) in the far field region, and the E-field and H-field are orthogonal to each other and the direction of propagation as with plane waves. Furthermore, in the far field zone the following relations between the E-field vector E, the H-field vector H and the power density S carried by the wave, are important:

$$E = 377 \cdot H \quad (1)$$

$$S = \frac{E^2}{377} \quad (2)$$

The effective isotropic radiated power (EIRP) from the aerial can be evaluated using the following relation:

$$\text{EIRP} = P_T \cdot 10^{\frac{G_i - l}{10}} \quad (3)$$

where P_T = transmitter power (W), G_i = aerial gain referred to a theoretical isotropic reference antenna (dB_i), l = insertion loss of the transmission line and of everything else connected between transmitter and aerial (dB).

In the far field zone and in free field conditions, the following relation:

$$E(r) = \frac{1}{r}\sqrt{\frac{377}{4 \cdot \pi} \cdot EIRP} \quad (4)$$

allows evaluation, in the maximum gain direction, of the E-field depending on the distance (r) from the aerial. However, this relation misses some factors, such as reflections by the ground, buildings, trees, and so on, and therefore overestimates E-field values in almost all cases.

For example, the E-field in the maximum radiation direction produced by an aerial with a gain of 17.4 dB_i, powered by a transmitter with a 100 W power rating, gives the values reported in Figure 1. The attention value of 6.0 V m^{-1} was recorded at a horizontal distance of $\sim$68 m from the aerial.

Figure 2 was obtained by Equation 4 and it shows – for various gain values – the variation in the minimum horizontal distance from the aerial in order to comply with the attention value at various radiation powers.

Numerical forecasting models developed in recent years and used by the phone operators to design their networks may successfully evaluate the expected values of E-field in fixed points at known distances from a mobile phone RBS.

2.2. *Numerical simulation*

The EMF produced by a mobile phone RBS situated on a rural area was evaluated using Aldena Telecomunicazioni NFA3D 1.4.08 EMF forecasting software, which meets the requirements of the Italian Technical Standard.[14,15]

The simulated RBS suitable for 2G and 3G mobile communication networks, such as the global system for mobile communications (GSM) and the universal mobile communications system (UMTS), was built using the latest available technology: Huawei SingleRAN Single BTS

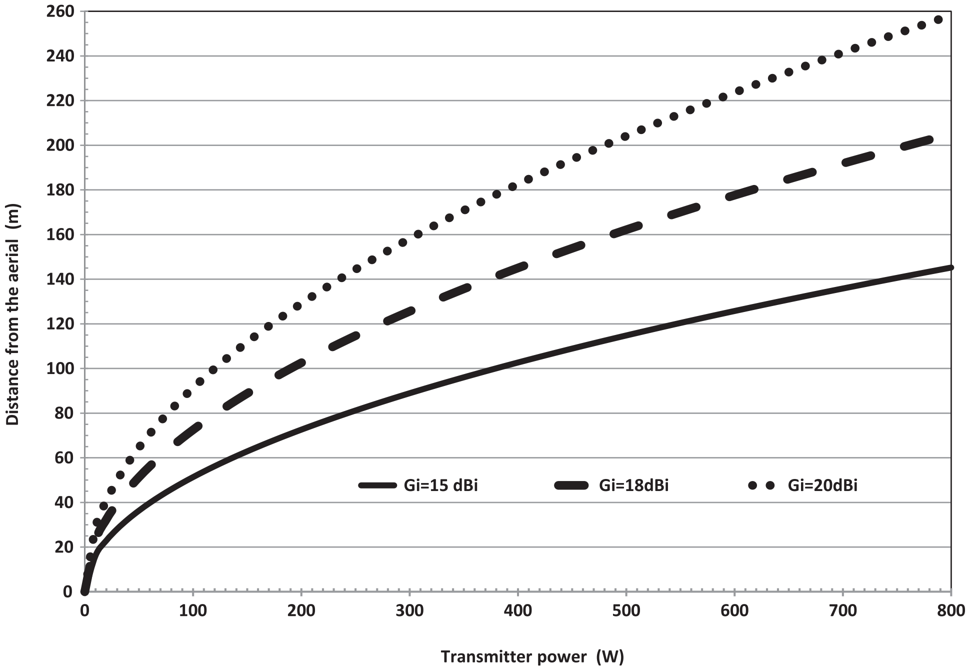

Figure 2. Horizontal distance from the aerial where the E-field is 6.0 V m^{-1} varying the effective radiation power for different gain values.

Table 3. Technical characteristics of the simulated radio base station.

Characteristic	GSM900	GSM1800	UMTS2100	UMTS900
Transmitter power (W)	60	60	60	60
Transmitter number	6	6	3	2
Total power (W)	360	360	180	120
Sector number	3	3	3	3
Sector azimuth (°)	0–120–240	0–120–240	0–120–240	0–120–240
Aerial type	Kathrein 80010204V02	Kathrein 80010439V01	Kathrein 80010439V01	Kathrein 80010204V02
Aerial gain (dB_i)	17.8	20.8	21.1	17.8
Horizontal beam width at − 3 dB (°)	65	63	60	65

BTS3900 Series. It allowed a spatial uniform signal distribution via a three-sector aerial system with a 120° layout. Each simulated transmitting sector operates in the GSM900, GSM1800, UMTS2100 and UMTS900 bands at full potentiality (Table 3). The signal was radiated through vertical dipole arrays with a back reflecting shield; for the technical characteristics we referred to Kathrein, the world's leading producer (Table 3).

The two representative variables in the real RBS installations were considered: (a) the aerial radio electric centre height above ground (RECh [m]); and (b) the aerial downtilt angle (DownTilt [°]). A rough estimate of the aerial radio electric centre height above ground could be made by looking at the aerial placement and the aerial holding structure referred to ground level; the downtilt angle is difficult to evaluate without suitable instrumentation. The interaction between these two physical characteristics greatly affects the E-field values in the space surrounding the aerial; for the aim of this paper the E-field variability was analysed at the mean human head height of 1.70 m above ground.

In order to do this, all of the possible combinations obtained by the following values of RECh (m): 9–12–15–18–21–24–27–30 and the following values of DownTilt (°) 0°–1°–2°–3°–4°–5°–6°–8°–10° were considered in the numerical simulations.

The global E-field E_{TOT} of the aerial studied is created with the contribution of the E-fields produced by each transmission band considered, according to the following equation:

$$E_{\mathrm{TOT}} = \sqrt{E^2_{\mathrm{GSM\,900}} + E^2_{\mathrm{GSM\,1800}} + E^2_{\mathrm{UMTS\,2100}} + E^2_{\mathrm{UMTS\,900}} + E^2_{\mathrm{ENV}}} \quad (5)$$

where the E_{ENV} value represents the E-field contribution of any kind of surrounding source, such as another RBS and radio or television broadcasting stations; in the simulations E_{ENV} was always considered as equal to zero because the characteristics of these additional sources were not known.

Table 4. Technical characteristics and geographical position of the radio base station examined.

Characteristic	Vieste	Giovinazzo	Barletta
RECh (m)	18.0	24.0	30.0
Sector 1 azimuth (°)	50	15	80
Sector 2 azimuth (°)	110	110	180
Sector 3 azimuth (°)	260	280	290
Latitude N	41°48′52.0″	41°11′26.0″	41°19′22.2″
Longitude E	16°11′02.1″	16°38′40.9″	16°15′35.3″

Note: RECh = aerial radio electric centre height above ground; Barletta, Giovinazzo, Vieste = areas in Italy.

2.3. *In situ measurements*

An experimental survey was made of the E-fields generated by three mobile telephone RBS situated on agricultural land in the rural areas of Barletta, Giovinazzo and Vieste (Italy). Evaluation of the E-field in the Fraunhofer region also enables assessment of the H-field.

The examined RBS had different aerial RECh and the three-sector aerial systems were arranged with different layouts; each system operated in the GSM and UMTS bands (Table 4).

The wide band E-field was measured at increasing distances from the RBS in the same direction of each transmitting sector using a Narda-PMM brand handheld PMM8053A EMF tester coupled with a Narda-PMM brand EP645 isotropic probe; both instruments had a valid verification test certificate. The main technical specifications of the EMF tester PMM8053A were as follows: 5 Hz to 40 GHz frequency range; dynamic range >120 dB (depending on sensor); 0.03 V/m to 100 kV/m E-field operating range; H-field operating range from 1 nT to 10 mT; resolution of 0.01 to 100 V/m and 0.1 nT to 0.1 mT; sensitivity of 0.1 to 1 V/m and 10 nT to 0.1 mT. The main technical specifications of the EP645 isotropic probe were as follows: 100 kHz to 6.5 GHz frequency range; 0.35–450 V/m E-field operating range; overload >900 V/m; dynamics >62 dB; 0.01 V/m resolution; 0.35 V/m sensitivity.

The probe was placed on an insulated stand at the conventional human head height of 1.70 m above ground.

All instrumentation was set for continuous 6 min E-field values data acquisition, and the mean value of the acquired data was considered to be the E-field value.

The Italian technical directives [14] impose measurement of the E-field at maximum aerial emission, so the peak should be evaluated during the time of day when most mobile telephone use takes place. Otherwise, this peak value could be estimated using extrapolation techniques in accordance with the experimental values obtained and the number of the available carrier waves for broadcasting at measurement time. When evaluating compliance of RBS sites where several radio frequencies are present, E-field values are calculated considering that all transmitters work simultaneously at their maximum power during a 6 min period.[15]

The average transmitted power and the consequent E-field from the RBS of 2G and 3G mobile communication systems varies in time with the amount of traffic, and may be statistically assessed using *ad hoc* software to acquire data about the communication load for a large number of sites over one or several days. This data is gathered by the operations support systems (OSS) generally used to monitor the networks.[16]

It was not possible to obtain data on the distribution RBS emission levels over the day, neither from studies conducted in Italy nor for the examined RBS. However, taking into account that the traffic in rural areas is lighter than in the urban areas [16] and that the transmitted power is generally lower at weekends,[17] the *in situ* measurements were carried out and recorded on working days, when it is reasonable to assume that most mobile telephone use takes place.[18,19]

3. Results and discussion

3.1. *Numerical simulation*

Considering each couple of RECh–DownTilt values, we plotted the E-field isopleths in a horizontal plane placed 1.70 m above ground level and the E-field isopleths in a vertical plane passing through the centre of each sector aerial; these curves were obtained by crossing egg-shaped solids whose surfaces have the same E-field value as the horizontal and vertical planes.

For example, the isopleths were plotted considering the combination RECh = 9 m and DownTilt = 0° (Figures 3(a) and (b)) in the horizontal plane, and the combination RECh = 30 m and DownTilt = 6° (Figures 4(a) and (b)) in the vertical plane.

The E-field spreads out according to the direction of the aerial sectors, thus for each of these directions it is possible to analyse the isopleth regarding the E-field value $E = 6.0$ V m^{-1} (Figures 3(a) and 4(a)); inside these isopleths, plotted in bold, the E-field value is greater than 6.0 V m^{-1} (Figures 3(a) and 4(a)). Because it is difficult to identify these areas outdoors, a dotted circle internally tangent to the three isopleths was plotted in order to mark out a circular area (Figures 3(a) and 4(a)). Inside this circle there are places where the E-field value is over 6.0 V m^{-1}.

The radius of the circular area is 215 m, considering the couple RECh = 9 m and DownTilt = 0° (Figure 3(a)), while the radius is 275 m, observing the couple RECh = 30 m and DownTilt = 6° (Figure 4(a)); these measurements can be taken as the shortest distances from the aerial in order to comply with the Italian limits.

The downtilt affects the E-field because as this angle increases, the isopleths are tilted increasingly towards the ground (Figures 3(b) and 4(b)). Furthermore, the 6.0 V

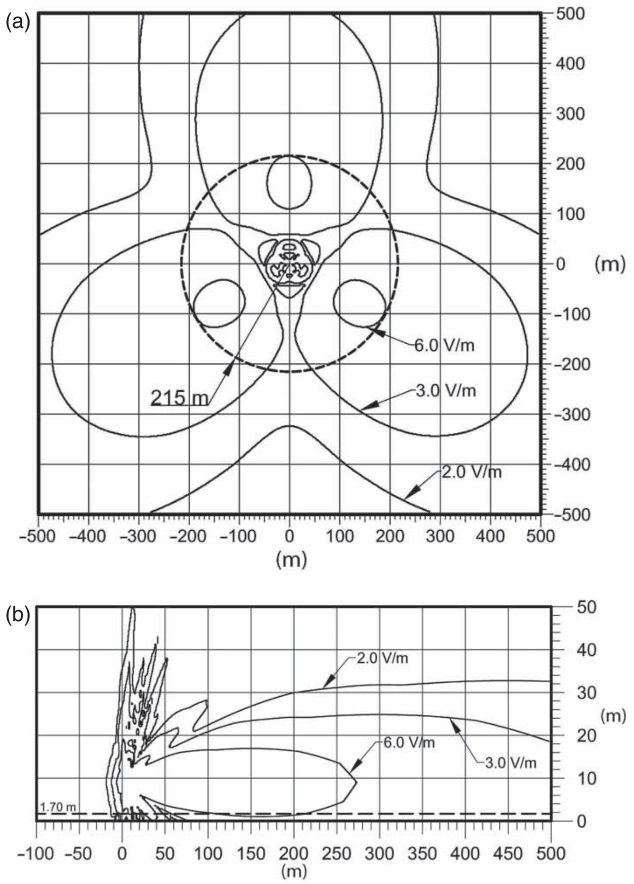

Figure 3. (a) RECh = 9 m-DownTilt = 0°: E-field horizontal radiation diagram (1.70 m above the ground level).
Note: RECh = aerial radio electric centre height above ground; DownTilt = aerial downtilt angle. (b). RECh = 9 m-DownTilt = 0°: E-field vertical radiation diagram at the centre of the aerial sector.
Note: RECh = aerial radio electric centre height above ground; DownTilt = aerial downtilt angle.

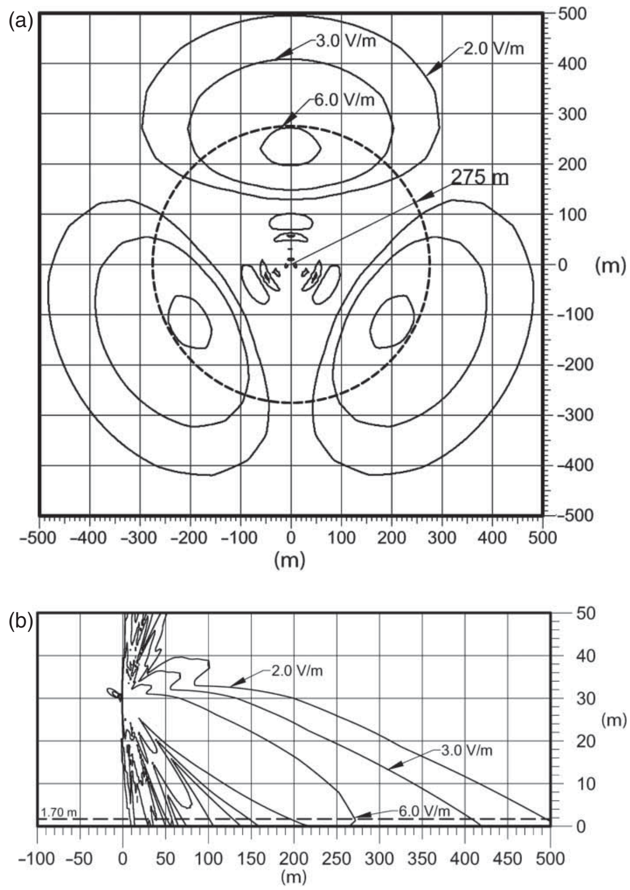

Figure 4. (a) RECh = 30 m-DownTilt = 6°: E-field horizontal radiation diagram (1.70 m above the ground level).
Note: RECh = aerial radio electric centre height above ground; DownTilt = aerial downtilt angle. (b) RECh = 30 m-DownTilt = 6°: E-field vertical radiation diagram at the centre of the aerial sector. Note: RECh = aerial radio electric centre height above ground; DownTilt = aerial downtilt angle.

m^{-1} isopleth was plotted in bold, whereas the line representing the height of 1.70 m above ground level was dotted (Figures 3(b) and 4(b)); this line crosses the 6.0 V m^{-1} isopleth at two points, and the point which is further from the aerial belongs to the dotted circle plotted in the corresponding horizontal planes (Figures 3(a) and 4(a)).

The simulations show that some combinations of RECh and DownTilt produce E-field values over 6.0 V m^{-1} at heights more than 1.70 m above ground level, so these combinations are disregarded in the present study. Table 5 shows the combinations of RECh and DownTilt that generate E-field values equal to the attention value ($E = 6.0$ V m^{-1}) at 1.70 m above ground level and the relative shortest distances from the aerial.

These estimated shortest distances from the aerial are overestimated for the following reasons:

(1) the simulations were carried out with the RBS working at full operating potential;
(2) the areas in which the E-field values are equal to or greater than 6.0 V m^{-1} are largely concentrated in the direction of RBS aerial sectors (Figures 3(a) and 4(a));
(3) inside the circular areas there are large zones in which the E-field values are significantly less than 6.0 V m^{-1}.

3.2. *In situ measurements*

The results of the *in situ* measurements show that the actual E-field values in the direction of each aerial sector are significantly lower than the attention values in the current Italian regulations (Table 6). In this respect, for the Vieste (sector 1) and Barletta RBS (sector 1), the E-field values were below the probe sensitivity (Table 6) at the greatest distance from the aerial. Furthermore, for the Giovinazzo RBS (sectors 1 and 3) higher results were registered at greater distances from the RBS. These irregularities may be explained by considering the likelihood that the radiated

Table 5. RECh–DownTilt combinations that generate $E = 6.0$ V m^{-1} at 1.70 m above ground level and the relative shortest distances from the radio base station.

Combination	RECh (m)	DownTilt (°)	Distance from RBS (m)
1	9	0	215
2	12	1	235
3	15	2	260
4	18	3	266
5	21	4	274
6	24	4	261
7	27	5	269
8	30	6	275

Note: RECh = aerial radio electric centre height above ground; DownTilt = aerial downtilt angle; RBS = radio base station.

Table 6. *In situ* measurements.

RBS	RECh (m)	Sector	Distance from RBS (m)	Measured E-field (V/m)
Vieste	18.0	1	39.0	1.31
			74.0	0.45
			112.0	*
		2	23.0	0.76
			67.0	0.59
			108.0	0.56
		3	25.0	1.01
			81.0	0.79
			123.0	0.41
Giovinazzo	24.0	1	19.0	1.39
			43.0	1.66
			65.0	1.43
		2	15.0	1.46
			34.0	1.36
			35.0	1.30
		3	18.0	1.41
			41.0	1.55
			68.0	1.37
Barletta	30.0	1	140.0	0.59
			170.0	0.48
			223.0	*
		2	22.0	0.74
			45.0	0.60
			109.0	0.39
		3	13.0	1.18
			57.0	0.60
			134.0	0.41

Note: * = below probe sensitivity, RBS = radio base station; RECh = aerial radio electric centre height above ground.

signal was reflected by buildings and/or trees along the directions of the sectors at certain distances from the aerial, producing a bias of the radiation pattern with an increase in the E-field.

In addition, an RBS is designed to avoid transmission at full power for extended periods of times, because 2G GSM networks cannot satisfy further incoming traffic demands without congestion at maximum power, and 3G UMTS networks can allocate new traffic requests during full power data transmission only by reducing the data rate assigned to other users. Furthermore, most networks use power regulation to reduce interference and save energy.[16]

In this respect, a Swedish survey of network measurement data collected from the OSS and validated with *in situ* measurements highlighted that for 2G networks, with two transceivers installed, the 90th percentile of average output power for rural sites during 24 h was 65% of the maximum available power, and the corresponding number for 3G networks was 31%.[16,20]

This may explain the significant differences between the calculated and measured E-fields. The calculated E-field values overlook reflections from the ground and trees, and allow assessment of the worst-case exposure of field workers because they were obtained with the RBS working constantly at full power. Luckily, this hypothetical situation may occur only during specific circumstances in order to manage traffic peaks, while in reality the average output is lower than the maximum most of the time. In addition, considering that the transmitter power at RBS antennas is directly proportional to the *EIRP* (Equation 3), at the same distance *r* from RBS, a decrease of about 50% of the *EIRP* value involves an E-field value reduction of about 75% (Equation 4). As a consequence, the actual power emitted by RBS antennas was sure to be lower than the maximum level during the *in situ* measurements, and the E-field values actually registered were much lower than the values which were calculated.

4. Conclusions

The adverse effects of high-level short-term exposure to EMF on health have been scientifically established, and the international exposure guidelines provide for protection of workers and the general public.

The RBS transmit frequency signals between mobile phones to the main telephone network, producing EMF which must be evaluated in order to ensure observance of the statutory limits. This study reports a methodology for evaluating the exposure of farm workers operating near mobile phone base stations. These workers are generally unaware of their exposure and the potential risks, and are not trained to take appropriate precautions. The viability of this study was tested according to the current Italian Regulations about general and occupational public exposure to time-varying EMF.

The numerical simulation of a 2G and 3G mobile communication network RBS working at full operating potential made it possible to evaluate the worst-case scenario for field worker exposure to EMF. The combinations between radio electric centre height and downtilt angle that generate E-field values equal to the Italian limit ($E = 6.0$ V m^{-1}) at 1.70 m above ground level and the relative shortest distances from the aerial beyond which the E-field is lower in all areas than the attention value are found by means of the simulation. On the other hand, the E-field values are equal to or greater than 6.0 V m^{-1} under the shortest distances in the areas in the direction of RBS aerial sectors, whereas they are significantly lower in the remaining areas. This is due to the asymmetrical radiation pattern composed of lobes, each of which is surrounded by regions of relatively weak radiation intensity.

The actual E-field produced by the three mobile telephone RBS was evaluated by *in situ* measurements; the values recorded were much lower than 6.0 V m^{-1} even at a short distance from the antennas.

Therefore, although further *in situ* measurements would be required for better assessment of these RBS, the results obtained show that the levels of exposure experienced by farm workers in the surrounding area falls within the Italian limits.

Finally, the case of farm workers operating near to base stations comes under Directive 2013/35 article concerning risk assessment, which stipulates that for workplaces where general public exposure has already been assessed it is not necessary to re-evaluate exposure levels for workers. In this respect, the Italian Regional Agencies for Environmental Protection (ARPA) authorize the activation of radio stations only if EMF exposure has been evaluated in accordance with the current administrative limits for both the general public and the working public. Therefore, according to this Directive, an employer who fulfils the obligations of the Italian Regulations on workplace health and safety is not obliged to carry out further assessment of risks arising from E-fields for farm workers whose workplace is in the vicinity of base stations.

Disclosure statement

No potential conflict of interest was reported by the authors.

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