

Electromagnetic Fields of Mobile Networks, from 4G to 5G, and Population Health: State of the Evidence, Controversies and Reasoned Risk Management in Developing Countries

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Abstract: The accelerated deployment of mobile networks, 4G today and 5G tomorrow, in developing countries is accompanied by public health concern that local authorities are poorly equipped to address. This article reviews the evidence: a purely thermal interaction mechanism demonstrated at public exposure levels, the 2011 IARC classification of radiofrequencies as possibly carcinogenic (group 2B), the contrasted results of the Interphone study, the 2018 US National Toxicology Program experimental signals in rats at exposures far above human ones, the 2021 ANSES collective expertise concluding that no established risk arises from 5G at deployed frequencies, but also landmark social episodes, the 2020 Italian ruling recognising an acoustic neuroma as an occupational disease, the Brussels moratorium and the 2020 mast fires. Exposure quantities, power density, specific absorption rate and tissue heating, are formalised and applied to the safety perimeter of a typical base station. A five-measure reasoned-precaution doctrine is proposed for regulators in developing countries, combining compliance with international limits, public measurements, local consultation and monitoring of the actual exposure burden, which is dominated by the handset at contact far more than by the neighbourhood mast.

Keywords: Electromagnetic Fields; Radiofrequency; 5G; Mobile Telephony; IARC; SAR; Base Stations; Risk Perception; Developing Countries.

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I. INTRODUCTION

Few environmental health topics combine, as the waves of mobile networks do, universal exposure, a physical risk that is low at regulatory levels and high social concern. In developing countries, where mobile telephony is the essential infrastructure of the economy and of services, the installation of a base station regularly triggers petitions, blockades and rumours, while local authorities, without

measurement means or doctrine, oscillate between silent authorisation and withdrawal under pressure. The worldwide episode of 2020, when dozens of masts were set on fire in Europe on the strength of a rumour linking 5G and the pandemic, recalls that managing this risk is as much social as physical [1].

This article, drawn from the electromagnetic-field chapters of a public health manual [2], answers three

questions: what do physics and epidemiology say about the health effects of radiofrequencies; what should be retained from the landmark controversies and decisions of the decade; and what management doctrine can a Sahelian regulator apply with its actual means?

II. METHOD AND EXPOSURE QUANTITIES

The approach combines a narrative review of international assessments, IARC Monograph 102 [3], the Interphone study [4], the NTP programme [5], the ANSES 5G expertise [6], the ICNIRP 2020 guidelines [7], with a quantitative formalisation of exposure. Three relations govern the far field of an antenna. The power density at distance d from an antenna of power P and gain G is:

$$S = \frac{P \cdot G}{4\pi d^2} \quad (1)$$

The safety perimeter, the distance below which the limit S_{lim} would be exceeded in the beam axis, follows:

$$d_{sec} = \sqrt{\frac{P \cdot G}{4\pi \cdot S_{lim}}} \quad (2)$$

And power density relates to the electric field through the impedance of free space:

$$S = \frac{E^2}{377} \quad (3)$$

In tissues, absorption is measured by the specific absorption rate SAR and the resulting heating:

$$DAS = \frac{\sigma E^2}{\rho} \quad (4)$$

$$\Delta T = \frac{DAS \times t}{c} \quad (5)$$

At mobile network frequencies, 700 MHz to 3.5 GHz for the bands deployed in Africa, the only interaction mechanism demonstrated at public exposure levels is thermal: the energy of a radiofrequency photon, a million times lower than that of an ionising photon, cannot break any chemical bond; any effect passes through heating, which international limits cap with safety factors of ten to fifty [7].

III. RESULTS

➤ The State of Epidemiological and Experimental Evidence

In 2011, the International Agency for Research on Cancer classified radiofrequency fields in group 2B, possibly carcinogenic, on the basis of limited indications concerning glioma and acoustic neuroma among very heavy telephone users [3]. The Interphone study, thirteen countries and more than five thousand cases, found no increase in overall risk, while observing a non-conclusive excess in the highest-use decile, weakened by recall bias [4]. In 2018, the US National Toxicology Program reported clear evidence of rare cardiac tumours in male rats exposed whole-body, for two years, at levels of 1.5 to 6 W/kg, far above real human exposures [5]. In 2021, the ANSES collective expertise concluded, for 5G, that there is no established new risk in the 3.5 GHz band at regulatory levels, and that research is needed for the 26 GHz millimetre band, not deployed in the subregion [6]. After four decades of expansion of mobile telephony, the cancer registers of highly covered countries show no increase in the incidence of brain tumours correlated with use [6, 7].

➤ The Landmark Episodes of the Decade

Table 1 Landmark Controversies and Decisions, and their Public Health Reading

Episode	Content	Public health reading
IARC 2B classification, 2011	Possibly carcinogenic, limited evidence	A vigilance signal, not established causality
Interphone, 2010	No overall excess; non-conclusive excess among heaviest users	Recall bias; encourages reducing handset exposure
NTP, 2018	Tumours in rats at 1.5 to 6 W/kg whole body	Exposures far above real human ones; relevance debated
Turin ruling, 2020	Acoustic neuroma recognised as occupational disease (intensive use, 12,500 hours)	A judicial compensation decision, not a scientific demonstration
Brussels moratorium, 2019-2020	5G deployment suspended in the name of strict local standards	A political precautionary choice, limits 50 times below ICNIRP
Mast fires, 2020	Dozens of masts burned over a 5G-pandemic rumour	The real health cost of disinformation: emergency network outages

➤ Application: The Safety Perimeter of a Typical Antenna

For a typical macro-cell antenna with an equivalent radiated power of 200 W in the axis, equation 2 gives, for the applicable ICNIRP public limit of about 10 W/m², a safety perimeter of a few metres in the beam axis, a beam tilted towards the horizon and inaccessible at ground level. At the foot of the mast, the position that concentrates neighbourhood concern, the measured exposure is typically

one hundred to one thousand times below the limit, the main lobe passing above the dwellings. Conversely, the handset in contact with the head exposes locally to SAR values of the order of one watt per kilogram during a call: the individual exposure burden is dominated by the handset, not by the mast, and a hands-free kit divides it by a factor of ten to one hundred by moving the source a few centimetres away, in line with the inverse-square law.

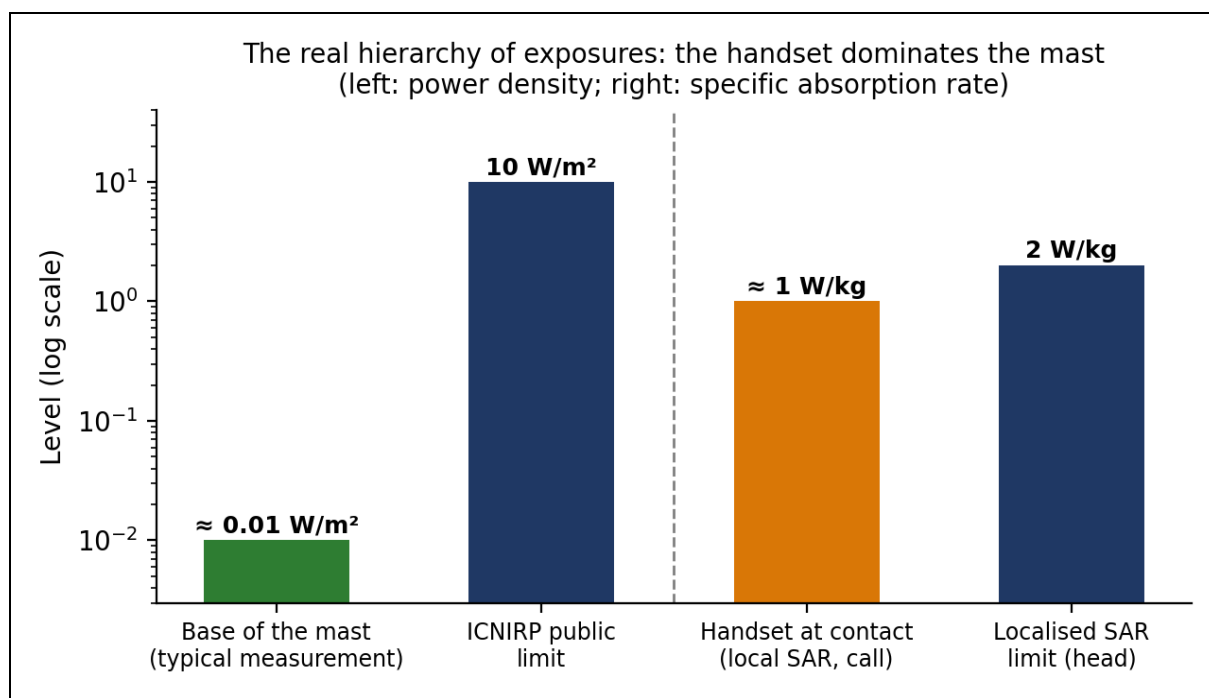


Fig 1 Hierarchy of Radiofrequency Exposures: Typical Measured Levels And International Limits [6, 7], Log Scale.

➤ A Five-Measure Reasoned-Precaution Doctrine

For a developing-country regulator, the article proposes: adopt the ICNIRP 2020 limits by reference together with mandatory site declaration; publish independent measurement campaigns, a few points per city suffice to objectify levels typically far below the limits; institute prior siting consultation, information reducing opposition more than the measurement itself; promote individual reduction gestures, hands-free kits, use under good coverage, which act on the dominant share of exposure; and maintain a formalised scientific watch on millimetre bands before any 26 GHz deployment.

IV. DISCUSSION

The contrast between the physical hierarchy of exposures, the handset dominating the mast by several orders of magnitude, and the social hierarchy of concerns, the mast concentrating opposition, is the central fact of the dossier. It is explained by the classical determinants of risk perception: the mast is suffered, visible and imposed while the handset is chosen and beneficial. The operational consequence is that a purely metrological policy fails: consultation and transparency are not concessions but the principal instruments of managing the real risk, which includes the emergency network outages caused by mast destruction.

The scientifically defensible position in 2026 holds in three propositions: at regulatory levels, no health effect is established apart from the thermal effects capped by the limits; non-conclusive signals, IARC 2B, the Interphone decile, NTP, justify continued research and simple individual reduction gestures, without justifying either a general moratorium or alarm; electromagnetic hypersensitivity describes real suffering whose blinded

provocation studies have not demonstrated a causal link with exposure, and which calls for respectful clinical care rather than denial or validation of the alleged mechanism [6, 8]. The limits of this work are the absence of published measurement campaigns in Chad, which the proposed doctrine aims precisely to create, and the dependence on international assessments for bands not yet deployed.

V. CONCLUSION

4G and then 5G will expose Sahelian populations to field levels far below international limits, but to levels of concern which can, for their part, exceed crisis thresholds. The proportionate response is neither denial nor moratorium: it is reasoned precaution, international limits, public measurements, consultation, individual gestures and scientific watch. The countries that adopt it early will spare themselves siting crises and will build, at low cost, the trust on which the digital infrastructure of their development depends.

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