ANSES Opinion
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The Director General

Maisons-Alfort, 20 June 2016

OPINION
of the French Agency for Food, Environmental and Occupational Health & Safety

on the expert appraisal of "Exposure to radiofrequencies and child health"

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ANSES's public health mission involves ensuring environmental, occupational and food safety as well as assessing the potential health risks they may entail.

It also contributes to the protection of the health and welfare of animals, the protection of plant health and the evaluation of the nutritional characteristics of food.

It provides the competent authorities with the necessary information concerning these risks as well as the requisite expertise and technical support for drafting legislative and statutory provisions and implementing risk management strategies (Article L.1313-1 of the French Public Health Code).

Its opinions are published on its website.

This opinion is a translation of the original French version. In the event of any discrepancy or ambiguity the French language text dated 20 June 2016 shall prevail.

On 12 July 2011, ANSES received a formal request from the Directorate General for Health (DGS), the Directorate General for Risk Prevention (DGPR) and the Directorate General for Competition, Consumer Affairs and Fraud Control (DGCCRF) to conduct the following expert appraisal: "Exposure to radiofrequencies and child health".

1. BACKGROUND AND PURPOSE OF THE REQUEST

In 2009, in its expert appraisal report "Update of the expert appraisal relating to radiofrequencies" (AFSSET, 2009), the Agency stated that there was still little knowledge on the characterisation of exposure of children to radiofrequencies and their possible health effects. In 2013, the Agency again insisted on the need to monitor the potential effects of radiofrequencies on child health (ANSES, 2013).

Children form a particularly vulnerable population, mainly because of the ongoing development of their organs and physiological functions. Moreover, due to the fact that they may use radiofrequency devices from an early age, and the resulting long-term exposure once they

reach adulthood, they should be regarded as one of the most exposed populations to electromagnetic radiofrequency fields.

There are many radio devices intended for children. They can be for recreational use, such as remote-control toys, or for surveillance purposes, such as baby monitors. These devices must be compliant with Directives 1999/5/EC[1] (the "R&TTE" Directive) and 2006/95/EC (the "Low Voltage" Directive) before being placed on the European market and must compulsorily bear a "CE" conformity marking, which renders the manufacturer or importer liable with regard to compliance with the essential health and safety requirements, as defined by the aforementioned Directives. At the present time, the Member States of the European Union cannot prohibit, restrict or hinder the free movement of these products if they comply with the regulatory requirements, unless their hazardous nature can be justified.

In the context of the *Grenelle* environmental round table, scientific and societal controversy about the level of protection provided by these directives to children exposed to emissions from radio devices led to the introduction, by the Act of 10 July 2010, of Article L.5231-4 of the French Public Health Code (CSP) stipulating that "the distribution, whether or not in return for payment, of items containing radio equipment specifically intended for use by children under six years of age may be prohibited by order of the Minister for Health, in order to limit the excessive exposure of children".

The formal request thus raises the question of whether the current regulatory provisions offer sufficient protection in terms of health and safety for children under six years of age. When certain radio equipment intended for children might pose a danger to them, application of Article L.5231-4 of the CSP may then be justified.

In order to respond to the questions posed by the request, the Agency undertook an expert appraisal whose objectives were as follows:

- produce an inventory, which is as comprehensive as possible, of the different radio products intended for children under six years of age (toys, communicating or monitoring items);
- conduct a review of the regulations in force and the applicable legislative texts concerning the exposure of children to electromagnetic fields emitted by radiofrequency devices;
- analyse the scientific publications relating to the influence of the electromagnetic field on people, and more specifically on children;
- characterise the exposure of children to certain radio devices;
- assess, if possible, the potential health risks to children associated with their exposure to electromagnetic radiofrequency fields emitted by radio devices intended for them.

[1] European Directive 1999/5/EC was repealed on 13 June 2016, and replaced by "Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC", also known as "RED", for Radio Equipment Directive.

2. ORGANISATION OF THE EXPERT APPRAISAL

2.1. Collective expert appraisal

The expert appraisal was carried out in accordance with French Standard NF X 50-110 “Quality in Expert Appraisals – General Requirements of Competence for Expert Appraisals (May 2003)”.

The expert appraisal falls within the sphere of competence of the Expert Committee (CES) on "Assessment of the risks related to physical agents, new technologies and development areas". Expert rapporteurs, members of the working group on "Radiofrequencies and health" and the CES on "Physical agents", were mandated to contribute to this collective expert appraisal work. The methodological and scientific aspects of the work were presented to the CES between 16 September 2011 and 3 May 2016. They were adopted by the CES on "Physical agents" during its meeting on 7 April 2016.

ANSES analyses the links of interest declared by the experts prior to their appointment and throughout the work, in order to avoid potential conflicts of interest with regard to the matters dealt with as part of the expert appraisal. The experts’ declarations of interests are made public via the ANSES website (www.anses.fr).

The expert appraisal work on the assessment of the health risks associated with the exposure of children to radiofrequencies drew on the analyses made in the reports "Update of the expert appraisal relating to radiofrequencies" (AFSSET, 2009) and "Radiofrequencies and health, update of the expert appraisal" (ANSES, 2013). The expert rapporteurs used this material as a basis for this expert appraisal, described in the report "Exposure to radiofrequencies and child health" and integrated new scientific publications into their analyses.

2.2. External contributions

A research and development agreement was entered into with the National Laboratory for Metrology and Testing (LNE), mainly to produce an inventory, as comprehensive as possible, of the different radio devices on the market intended for children under six years of age (toys, communicating or monitoring items), and conduct a review of the regulations in force and applicable legislative texts concerning the exposure of children to the fields emitted by radio devices. The information in the expert appraisal report, relating to the market situation and the regulations, is based in part on the report produced by the LNE in 2012. Measurements of exposure to a walkie-talkie, whose levels of emitted electric fields measured by the LNE were particularly high, led ANSES to commission a laboratory accredited by COFRAC[2] to conduct measurements of the specific absorption rate (SAR) generated by this device in the configuration of use stipulated by the manufacturer (at a distance of 5 cm), and also in reasonably foreseeable configurations of use, in contact with the body. For all the configurations tested, the results showed a maximum SAR below the exposure limit value of 2 W/kg.

Lastly, in a letter dated 15 July 2015, the French Frequency Agency (ANFR) sent ANSES the results of SAR measurements from mobile telephones in a situation of use in which they were in contact with the body, which contributed to the discussion on the levels of exposure of children to radio devices. These data supplied by the ANFR concern both children and adults.

[2] French Accreditation Committee.

2.3. Public consultation

The Agency brought the expert appraisal report in a pre-final state, i.e. without any conclusion or recommendations, to the attention of the members of the scientific community and interested stakeholders, in order to gather their comments and take them into account in the drafting of the final expert appraisal report. This consultation ran from 9 June to 21 August 2015.

All comments received were analysed by the Agency: four meetings were held with the expert rapporteurs, these served to contribute to the drafting of the responses to the comments, discuss the new studies to be incorporated in the report and develop the conclusions and recommendations.

The comments and responses are available as an annex table for downloading from the Agency's website as a complement to the expert appraisal report.

2.4. Description of the method: from literature monitoring to assessing the level of evidence

The expert appraisal presented in this report follows the methodological principles outlined in Chapter 6 of the ANSES report on the effects of radiofrequencies (ANSES, 2013) with regard to the identification of articles from the scientific literature and the analysis of publications.

2.4.1. Literature review

The period of bibliographic research initially covered 1 January 2005 to 31 December 2013. Scientific articles published in peer-reviewed journals and the results of collective expert appraisals by international agencies were identified and examined. Studies published before 28 February 2014 and mentioned during the public consultation were taken into account in the final expert appraisal report.

A literature search was conducted to identify studies focusing on the effects of electromagnetic radiation on the human body, targeting the exposure of children under six years of age, in particular from toys emitting electromagnetic fields (for example remote-control cars and walkie-talkies, using frequencies of 27 MHz, 40 MHz and around 433 MHz), and for radiocommunication devices intended for children, emitting at the frequencies of the major wireless communication protocols (GSM, DECT, Wi-Fi, i.e. the frequency range from 800 MHz to 2.5 GHz).

Most of the published articles identified examined exposure to the characteristic GSM or UMTS signals of mobile telephones, which is why the report mainly drew on data associated with exposure to mobile telephones.

There are few studies on children under six years of age. As most of the articles listed consider that the first use of mobile telephones rarely takes place before seven years of age, studies on older children (up to 16 years) were taken into account to study the effects of exposure to radiofrequencies. In addition, with the aim of understanding all the phases of their development, which constitutes a period of heightened sensitivity, the available studies that were examined covered exposure from the *in utero* period through to young adulthood.

2.4.2. Analysis of articles

Certain scientific studies examined by the Working Group on "Radiofrequencies and health" and analysed in the previous ANSES report on the effects of radiofrequencies (ANSES, 2013) were examined again in the report "Exposure to radiofrequencies and child health".

Each study was analysed by at least two experts; the part of the study concerning the exposure protocol was analysed by an expert physicist, and the part on the health effects by expert epidemiologists or biologists, depending on the nature of the study. Each expert reviewer completed an analysis grid with the support of the ANSES scientific coordinator. A study analysis table was created, listing in particular the various relevant analysis criteria, the expert rapporteurs' comments about the methodologies (mainly on exposure and experimentation), the conclusions advanced by the authors, and the sources of funding for each study. In each case, the quality of the study, i.e. the relevance and rigour of its protocol and the analysis of the results by the authors (statistical analyses in particular), determined its inclusion in the assessment of the level of evidence for each effect studied, regardless of its result.

2.4.3. Method of assessment of the level of evidence

The method of assessment of the levels of evidence deployed for the expert appraisal is built on the Agency's earlier work, conducted in particular for the report published in 2013; the method was reviewed and adapted by the experts for the needs of this current expert appraisal, in particular with regard to the matrices for classifying the level of evidence for the health effects.

The studies on the biological effects were included in the procedure for assessing the level of evidence for the observed health effects, for example as a mechanistic explanation, and are described in an independent section. The studies using *in vitro* models, carried out with the aim of searching for biological mechanisms to explain the possible health effects, were examined in detail in the ANSES report published in 2013. While they have not been reviewed in this report, their conclusions were *de facto* taken into account by the expert appraisal.

Finally, all the assessment criteria were examined as a whole, in order to achieve an overall assessment for the child of the impact of radiofrequencies, for each effect studied.

The classification of an effect is the result of a process of collective assessment and is based on the assessment criteria extracted from epidemiological, clinical and toxicological studies on humans and laboratory animals. The expert appraisal report presents in detail the process for determining the level of evidence adapted to the specific case of the assessment of the effects of radiofrequencies on child health.

3. ANALYSIS AND CONCLUSIONS OF THE CES

3.1. Results and conclusions of the expert appraisal

3.1.1. Characterisation of exposure

The data available on exposure show strong expansion of the use of new technologies, especially among very young children. The sources of exposure are very numerous, differing in nature and intensity, and by the frequency of the emitted radiation. The multiplicity and diversity of places frequented by children (home, school, public places, sports and cultural facilities) generate highly variable exposure situations, while the uses of radio devices (tablet computers,

connected toys, *etc*.) are also evolving rapidly. Many toys emitting electromagnetic fields, such as connected toys, are arriving on the market. Children have their own mobile telephone at an ever earlier age, even if the first use currently rarely takes place before seven years of age.

Measurements of the local SAR from a mobile telephone in contact with the body, carried out by the ANFR in 2015, showed, from a sample of mobile telephones, that the resulting exposure can sometimes be high: among the 95 mobile telephones tested by the ANFR, 89% of them measured in contact with the body had a SAR above 2 W/kg and 25% had a SAR above 4 W/kg. Moreover, for 25% of the tested telephones with a SAR in contact with the body above 2 W/kg, the instructions for use did not specify the minimum distance for use.

Numerical models of exposure of the head show that, for anatomical reasons (size, weight) or reasons associated with the dielectric properties of young or immature tissues, children may be more exposed than adults, in particular in the areas of the brain closest to the cranial cavity.

In addition, studies having assessed the SAR for the "whole body" reported higher exposure levels in children than in adults, in particular in two frequency ranges: around 100 MHz and around 1 to 4 GHz. The SAR can then exceed the basic restrictions by 40% when exposure is equal to the maximum permitted level for adults (reference levels). This means that for any person shorter than 1.30 m, the regulatory exposure limit values are less appropriate.

3.1.2. Assessment of the level of evidence for the effects of radiofrequencies on child health

The methodology described previously was used to classify the different potential effects of radiofrequencies on child health. The synthesis of the evidence and the levels of evidence for the existence of each studied effect are presented in the table below.

A number of the epidemiological studies analysed used collections of data on use of the mobile telephone as a measure of exposure to radiofrequencies. In practice, however, among children aged 8 to 12 years and adolescents (13 - 17 years), there is a low correlation between exposure to radiofrequencies and duration of use of the telephone, self-reported by questionnaire. In addition, the duration of use of the mobile telephone differs between that reported by operators and that estimated by users.

Moreover, some observed health effects may be the result of exposure to radiofrequencies, exposure to other physical agents (blue light, *etc.*) emitted by wireless communication devices, or how these devices are used. Thus, the use of the mobile telephone (conditions, duration, frequency of use, *etc.*) can be considered as possibly introducing a major confounding factor when any attempt is made to characterise the association between certain health effects and exposure to radiofrequencies. For example, the hypothesis of a link between the use of the mobile telephone and the onset of mental health disorders as described in studies (impaired well-being, depression, sleep disorders, *etc.*) is more plausible than the hypothesis of a link between the use of the mobile telephone and the onset of health effects of a different nature, such as cancer.

Therefore, taking confounding factors of a psycho-social nature into account in the analysis of the risk associated with the use of mobile communication tools is an important criterion for determining the credit to be granted to the results of studies and their interpretation.

Thus, according to the available studies on the health effects of radiofrequencies that were analysed, the collective expert appraisal work concluded as to a possible effect of radiofrequencies on:

- cognitive functions: the results showing acute effects were based on experimental studies with well-controlled methodologies;
- well-being: these effects may however be linked to the use of the mobile telephones rather than to the radiofrequencies they emit.

In contrast, it is not possible to conclude from the current data as to whether or not radiofrequencies have effects on children's:

- behaviour;
- auditory functions;
- teratogenic effects and development;
- male and female reproductive systems;
- carcinogenic effects;
- immune systems;
- systemic toxicity.

Table : Classification of evidence and the level of evidence for each studied effect in children

Studied effect	Evidence supporting the existence of the studied effect **in human clinical and epidemiological studies**	Evidence supporting the existence of the studied effect **in animal models**	Classification of the **level of evidence for the effect in children**
Behaviour	It is **not possible to conclude from the available evidence whether or not** radiofrequencies have an effect.	**-** It is **not possible to conclude from the available evidence whether or not** radiofrequencies have an effect. **-** Concerning locomotor activity during exposure in a period of development in the animal, the available evidence **supports the absence of any effect** of radiofrequencies.	It is **not possible to conclude from the available data whether or not** radiofrequencies have an effect on children's behaviour.
Cognitive functions	There is **limited** evidence to conclude as to whether radiofrequencies have an effect on cognitive functions.	There is **limited** evidence to conclude as to whether radiofrequencies have an effect on cognitive functions.	It can be concluded from the available data that there is **a possible effect** of radiofrequencies on children's cognitive functions.
Auditory functions	It is **not possible to conclude from the available evidence whether or not** radiofrequencies have an effect.	It is **not possible to conclude from the available evidence whether or not** radiofrequencies have an effect.	It is **not possible to conclude from the available data whether or not** radiofrequencies have an effect on children's auditory functions.
Sleep	It is **not possible to conclude from the available evidence whether or not** radiofrequencies have an effect.	It is **not possible to conclude from the available evidence whether or not** radiofrequencies have an effect.	It is **not possible to conclude from the available data whether or not** radiofrequencies have an effect on children's sleep.
Well-being	There is **limited** evidence to conclude as to whether radiofrequencies have an effect on well-being.	Absence of data.	It can be concluded from the available data that there is a **possible** effect of radiofrequencies on children's well-being.

Studied effect		Evidence supporting the existence of the studied effect **in human clinical and epidemiological studies**	Evidence supporting the existence of the studied effect **in animal models**	Classification of the **level of evidence for the effect in children**
Reproduction and development	**teratogenic effects and effects on development**	Absence of data.	The available evidence **does not show any effect** of radiofrequencies on teratogenic effects and development.	It is **not possible to conclude from the available data whether or not** radiofrequencies have a teratogenic effect or effect on children's development.
	female reproductive system	Absence of data.	It is **not possible to conclude from the available evidence whether or not** radiofrequencies have an effect on the female reproductive system.	It is **not possible to conclude from the available data whether or not** radiofrequencies have an effect on the female child's reproductive system.
	male reproductive system	Absence of data.	It is **not possible to conclude from the available evidence whether or not** radiofrequencies have an effect on the male reproductive system.	It is **not possible to conclude from the available data whether or not** radiofrequencies have an effect on the male child's reproductive system.
Carcinogenesis		It is **not possible to conclude from the available evidence whether or not** radiofrequencies have a carcinogenic effect.	It is **not possible to conclude from the available evidence whether or not** radiofrequencies have a carcinogenic or co-carcinogenic effect.	It is **not possible to conclude from the available data whether or not** radiofrequencies have a carcinogenic effect on children. To the extent that tumours in children are not comparable to tumours in adults, it is difficult to extrapolate to children the conclusions of the 2013 report showing a limited effect of radiofrequencies in adults. This, however, does not rule out the possibility of exposed children developing tumours at a later date.

Studied effect	Evidence supporting the existence of the studied effect **in human clinical and epidemiological studies**	Evidence supporting the existence of the studied effect **in animal models**	Classification of the **level of evidence for the effect in children**
Immune system	Absence of data.	It is **not possible to conclude from the available evidence whether or not** radiofrequencies have an effect on the immune system.	It is **not possible to conclude from the available data whether or not** radiofrequencies have an effect on children's immune systems.
Systemic toxicity	Absence of data.	It is **not possible to conclude from the available evidence whether or not** radiofrequencies cause systemic toxicity.	It is **not possible to conclude from the available data whether or not** radiofrequencies cause systemic toxicity in children.

3.2. Recommendations of the CES

3.2.1. Recommendations concerning the reduction of levels of exposure to radiofrequencies

Considering:

- the increase in the exposure of children's bone marrow or brains compared to adults shown by some dosimetric studies;
- the increase of the "whole body" SAR in younger children compared to adults, associated with differences in morphology and anatomy, which can lead to the basic restrictions (SAR) being exceeded by 40% in worst-case conditions (high environmental exposure equal to the regulatory limit values);
- the high levels of exposure generated by mobile telephones in contact with the body;
- the results of epidemiological studies highlighting possible effects of radiofrequencies on children's cognitive function and well-being;
- the recommendation by the Health Council of the Netherlands to lower the exposure limit values (reference levels) in certain frequency bands, and their revision adopted by Health Canada[3], in order to take account of the specificities of children in terms of exposure to radiofrequencies;

the CES recommends, with regard to the regulations:

- adapting the regulatory exposure limit values to take into account the specificities of children relating to their exposure to radiofrequencies;
- before they can be placed on the market, taking SAR measurements of terminals other than mobile telephones (tablets, toys, *etc.*) under actual conditions of use and including the results in the device's instruction leaflet, and subjecting this SAR to regulatory limit values depending on the likely use of the device;
- extending the regulatory provisions limiting advertising for mobile telephones targeting children to other communicating devices intended for children.

The CES recommends, in particular to parents, concerning the reduction of exposure:

- limiting the use by children of emitting electronic devices (tablets, telephone, *etc.*);
- when the telephone is communicating, not leaving it in contact with the body, to avoid potential thermal effects.

3.2.2. Recommendations concerning the reduction of use of the mobile telephone

Considering:

- the results of epidemiological studies highlighting mental health problems in adolescents with "problematic use of mobile telephones";
- the strong expansion of the use of new technologies, especially among very young children;

[3] See sections 3.1.2 Opinion of the Health Council of the Netherlands (2011) and 3.1.3 Revision of Safety Code 6 on Radiation Emitting Devices (Health Canada - 2014) of the expert appraisal report.

the CES recommends that parents encourage children to adopt reasonable use of mobile telephones (avoiding night-time communications and limiting the frequency and duration of calls, *etc.*).

3.2.3. Recommendations concerning studies and research

Studies seeking to improve the characterisation of exposure, in particular to other signals than those from mobile telephones

Considering in particular:

- the emergence of new mobile communication technologies that use new types of signals (5G, connected objects, *etc.*);
- that the data currently available mainly concern 2G and 3G type signals and Wi-Fi;
- that a challenge study in adolescents highlighted different results (modification of electroencephalogram parameters) depending on the signal used (2G *versus* 3G);

the CES recommends undertaking studies, mainly in order to:

- better characterise how the different radio devices are used by children (what types of devices, what frequency and duration of use, from what age, *etc.*);
- determine the actual exposure of children to radiofrequencies in a situation of use for all radio devices.

In addition, the CES stresses the importance of searching for possible health effects associated with exposure to new radiofrequency signals.

Experimental studies in humans and animals

Considering:

- the demonstration in two clinical studies of slight to moderate differences in the electroencephalographic readings in the theta (4-8 Hz) and beta (12-15 Hz) frequency bands between exposed and non-exposed children;
- the effects relating to exposure to radiofrequencies on brain excitability in healthy adults or more generally on the electrical activity of the brain (EEG, evoked potentials, *etc.*) (see ANSES report, 2013);
- that epilepsy is a neurological disease that involves neuronal hyperexcitability and/or an anomaly of synchronisation of neuronal populations, and that the incidence of this disease varies considerably depending on age;

the CES recommends:

- conducting studies on the effects of radiofrequencies related to the studied brain functions, either in brain imaging in children or by recording the electrical activity of the brain (EEG), in basal condition or during stimulation (cognitive tasks), in children or animals, at various ages of development;
- studying the impact of radiofrequencies on electroencephalographic readings or on the occurrence of epileptic seizures in children.

Also considering:

- the discrepancy in the results of epidemiological and experimental studies on cognitive functions, which either conclude as to an absence of any effect or to an improvement in performance;
- the discrepancy between the results of various studies in animals, with effects that may depend on the type of task;

the CES recommends:

- conducting challenge studies in children exploring various cognitive functions (memory, reasoning, executive functions, attention) at different ages, in situations of exposure or non-exposure to radiofrequencies;
- undertaking studies in animals exploring the effects of exposure to radiofrequencies on cognitive functions (memory, executive functions, attention) associated with a study of morphology and brain plasticity (electrophysiological approaches, immunohistochemical markers, *etc.*);
- studying the potential effects on brain development of exposure to radiofrequencies according to age, undertaking longitudinal studies in juvenile animals of several ages, and comparing them with adults, to identify periods of potential sensitivity/vulnerability.

<u>Epidemiological studies</u>

Considering, in particular:

- that children are exposed ever earlier to devices emitting electromagnetic radiofrequency fields;
- the importance of the confounding factor introduced by how mobile telephones are used when estimating exposure to radiofrequencies;

the CES recommends:

- updating the assessment of the carcinogenic risk of radiofrequencies in children when the results of the MOBi-Kids study are published;
- taking into account the confounding factors related to the use of radio devices and the effects on health, particularly when the studied health effects concern perceived health, behavioural disorders, impaired well-being, depression, *etc.* These confounding factors can be in the area of mental health, the psychological construct, family relationships, *etc.*

<u>Psycho-social effects of uses of new technologies</u>

Considering:

- the strong expansion of the use of new technologies, especially among very young children;
- the epidemiological studies highlighting mental health problems in adolescents with "problematic use of mobile telephones";

the CES recommends studying the impact of the uses of communication technologies on:

- disorders relating to mental health (stress, addiction, depression, *etc.*);

- family relations, school learning, *etc.*

4. AGENCY CONCLUSIONS AND RECOMMENDATIONS

Like adults, children are exposed to various sources of electromagnetic radiation present in the environment: low-frequency fields from electricity transmission and distribution, and radiofrequency fields from sources of radio and television broadcasting, mobile communication, and in particular all domestic appliances that emit radiation. Some of these emitting devices are specifically intended for children: remote-control toys, baby monitors, surveillance devices, walkie-talkies or communicating robots. Others, initially intended for adults, are now sometimes specifically designed for children (wireless tablets, for example), or used from an ever earlier age (mobile telephones).

Because of the extremely rapid development of mobile communication technologies, which place these radiofrequency sources close to and sometimes in contact with the body, most children today, unlike previous generations, are exposed from a very early age, and even from the *in utero* development phase, to multiple emitting radiofrequency sources.

The expert appraisal conducted by the Agency has brought together the recent available knowledge on the specificities of exposure of children to radiofrequencies and their potential biological and health effects, as explored by research. In order to assess the level of evidence for the potential health effects reported in the literature, the expert appraisal followed and adapted the methodological principles outlined in the ANSES report on the effects of radiofrequencies (ANSES, 2013) concerning the identification of articles from the scientific literature, the analysis of publications, and the determination of evidence.

In 2015, the Agency submitted the expert appraisal report for public consultation *via* its website, in order to collect any information and data that would supplement, where appropriate, the survey carried out by the experts. The comments received from interested stakeholders (around a hundred) were analysed in the framework of the expert appraisal, and a response was provided to each one, available as an annex table for downloading from the Agency's website as a complement to the expert appraisal report and this opinion.

ANSES endorses all the conclusions and recommendations, reiterated in Section 3 of this opinion, of its Expert Committee on "Physical agents, new technologies and development areas". Below, it clarifies and supplements the recommendations aimed at adapting the regulatory limit values, limiting the exposure of children and encouraging reasonable use of wireless communication technologies.

- *Reconsider the regulatory exposure limit values and exposure indicators*

  Besides the wide diversity of emission sources exposing children to electromagnetic radiofrequency fields, the expert appraisal work highlighted the fact that, in certain frequency bands, children could be more exposed than adults. Indeed, in the case of "environmental" exposure, i.e. associated with distant sources (such as mobile telephone base-station antennas or radio and television broadcasting transmitters), the small size of children may, through the resonance effect, generate higher average exposure over the whole body than for adults.

  These observations had already led the Health Council of the Netherlands, in 2011, to consider that the reference levels of around 2 GHz defined by the ICNIRP (International Commission on Non-Ionising Radiation Protection) and adopted by European Council Recommendation

1999/519/EC[4], should be adjusted. Similarly, on 13 March 2015, Health Canada published a new version of its "Safety Code 6", which sets exposure limit values for electromagnetic fields, in which the reference levels were reduced slightly, in order to increase the safety margins, especially for children[5].

In this context, the Agency recommends reconsidering the reference levels aiming to limit environmental exposure to electromagnetic radiofrequency fields (related to distant sources), in order to ensure that the safety margins are large enough to protect the health and safety of the general population, and more particularly of children.

In the case of local exposure, for example of the head, with emission sources such as mobile telephones, the analysed studies show that, yet again, children may be more exposed than adults because of their morphological and anatomical features and the nature of their tissues, albeit with very high variability in the results. With regard to near-field exposure induced by the use of mobile communication devices, the Agency considers that it is necessary to;

- reassess the relevance of the specific absorption rate (SAR) used to establish exposure limit values for individuals, for the purposes of protection against the known and proven health effects (thermal effects) of radiofrequencies;
- and develop a representative indicator of the actual exposure of mobile telephone users, regardless of the conditions of use: signal used, good or bad reception, method of use (voice calls, loading data, *etc.*).

▪ *Limit the exposure of children to electromagnetic fields*

The results of the expert appraisal have moved ANSES to reiterate the recommendation made in its opinions published in October 2009 (Radiofrequencies - Update of the expert appraisal relating to radiofrequencies) and October 2013 (Radiofrequencies and Health - update of the expert appraisal), calling for a reduction in exposure of children to radiofrequencies emitted by mobile telephones, by promoting moderate use of these devices and favouring the use of hands-free kits.

In addition, the Agency recommends:

- that the current regulations seeking to regulate exposure of the general population to electromagnetic fields emitted by equipment used in telecommunications networks or by radio installations (Decree No. 2002-775 of 3 May 2002) be extended to other sources of artificial emissions of radiofrequency radiation, whose compliance with the exposure limit values cannot be established in advance;
- that all devices emitting electromagnetic fields intended to be used in close proximity to or by children (tablet computers, baby monitors, *etc*.), and whose maximum exposure must comply with the regulatory limit values, fulfil the obligations to inform the public (Article 184-I of Act No. 2010-788 of 12 July 2010 as amended by Act No. 2015-136 of 9 February 2015);
- ensuring under all circumstances that the regulatory exposure limit values are enforced, regardless of the mobile emitting devices used and their conditions of use (positioning in contact with the body).

[4] These limit values were incorporated in the national regulations by Decree No. 2002-775 of 3 May 2002.

[5] In March 2015, Health Canada thus lowered the electric field environmental exposure limit values (reference levels) for example to 32 V/m at 900 MHz and 41 V/m at 1800 MHz (the current values in France are respectively 41 V/m and 58 V/m).

- *Promote rational use of mobile communication technologies*

In addition, independently of the issue of radiofrequency exposure, several studies have highlighted an association between "problematic use" (intensive and inappropriate) of mobile telephones by young people and mental health problems (depression, suicidal thoughts, risk behaviour, *etc.*). However, it was not possible to use these studies to explore the causality of the observed associations.

Consequently the Agency recommends:

- that additional studies assess the health and psychosocial impact (school learning, social and family relationships, *etc*.) in children associated with the use of mobile communication technologies, especially because of addictive phenomena, circadian rhythm disorders, *etc*.;
- that, in the meantime, parents encourage children to adopt rational use of mobile telephones, for example by avoiding night-time communications and limiting the frequency and duration of calls, *etc.*;
- and, more generally, discouraging the use of all mobile communications devices by children, for example by extending to these devices the regulatory provisions prohibiting advertising aiming directly at promoting the sale, provision, use or utilisation of a mobile telephone by children under fourteen years of age.

The Director General

Roger GENET

KEYWORDS

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Radiofrequencies, child, radio devices, exposure, risk assessment, health, mobile phone, Wi-Fi, 3G, 4G, SAR.