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Brief Communication

Mobile Phones and Children: Is Precaution Warranted?

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Are there health related arguments to recommend that children limit their use of mobile telephones? The International Expert Group on Mobile Phones from the UK concluded so, but did not come up with convincing scientific data to back this statement. The Health Council of the Netherlands approached the problem by considering whether developmental arguments might be found, i.e., asking if there reason to believe that the heads of children are more susceptible to the electromagnetic fields emitted by mobile telephones than those of adults. It concluded that no major changes in head development occur after the second year of life that might point at a difference in electromagnetic susceptibility between children and adults. The Health Council therefore sees no reason to recommend limiting the use of mobile phones by children. Bioelectromagnetics 25:142–144, 2004.

Key words: specific absorption rate; electromagnetic wave propagation; dieletric parameters; nervous system; hazard

The issue of whether children are especially sensitive to exposure to electromagnetic fields from mobile telephones has been brought to the forefront by the recommendations made by the International Expert Group on Mobile Phones of the United Kingdom that children should refrain from using telephones as much as possible [Independent Expert Group on Mobile Phones (IEGMP), 2000]. These recommendations have received worldwide attention and press coverage, and inspired several governments to take or announce action. For instance, the UK government published a brochure recommending that ''children and young people'' should use mobile telephones as little as possible [UK Department of Health, 2002]. And last year, the Minister of the Interior of Thailand stated that he is contemplating an actual ban of the use of mobile phones by children [Channelnewsasia, 2002]. These are far reaching actions affecting millions of users, but they are not based on solid scientific evidence.

There has been only very limited study that specifically addresses the issue of a possible difference in sensitivity between adults and children. Only several model studies have been conducted into how electromagnetic waves propagate in children's size heads, relative to those of adults [Gandhi et al., 1996; Schönborn et al., 1998].

In the concluding chapter of its report, the IEGMP states in paragraph 6.63: ''The balance of evidence indicates that there is no general risk to the health of people living near to base stations where the exposures are only small fractions of guidelines. However, it was suggested to us that children might be especially vulnerable to any adverse effects of RF radiation. There is evidence that at the frequencies used in mobile phone technology, children will absorb more energy per kilogram of body weight from an external electromagnetic field than adults (see paragraph 4.37). A 1 year old could absorb around double, and a 5 year old around 60%, more than an adult. Additionally, since children are being exposed to RF radiation from base stations (and from mobile phones) from a younger age than

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adults, they will have a longer time in which to accumulate exposure over the course of their lives, and a longer time for any delayed effects of exposure to develop.''

On the basis of this conclusion, the IEGMP makes the following recommendation in paragraph 6.90: ''If there are currently unrecognised adverse health effects from the use of mobile phones, children may be more vulnerable because of their developing nervous system, the greater absorption of energy in the tissues of the head (paragraph 4.37), and a longer lifetime of exposure. In line with our precautionary approach, we believe that the widespread use of mobile phones by children for non-essential calls should be discouraged. We also recommend that the mobile phone industry should refrain from promoting the use of mobile phones by children.''

In the quoted concluding sections, the IEGMP refers to paragraph 4.37 for the scientific background for its conclusions and recommendations. The only statement on the issue in that paragraph, however, reads: ''The SAR produced by a particular value of electric field is somewhat larger in children than in adults because their tissue normally contains a larger number of ions and so has a higher conductivity [Gabriel, 2000].'' The reference indicated, the only scientific evidence used for the recommendation to limit the use of mobile phones by children, appears to be a personal communication. This information does not give any backing to the statement that ''A 1 year old could absorb around double, and a 5 year old around 60%, more than an adult.'' In contrast to the thorough manner in which the IEGMP interprets the scientific literature on which it bases its conclusions in general, this is a rather questionable procedure. The only valid argument it puts forward, is that it takes a precautionary approach. But even then, there should be real indications for an effect, not merely assumptions. The argument that children have a longer life span than adults and consequently can be exposed over a longer period is equally valid for adolescents—the question is where to draw the line, if any?

The Health Council of the Netherlands, in its recent report on mobile phones [Health Council of the Netherlands, 2001], attempted to gather scientific information on a possible higher electromagnetic sensitivity of children. It briefly discusses therefore the early development of the human head and brain.

In neonates, the head accounts for about a quarter of the body length. In adults, the corresponding proportion is around 10%. Growth of the head primarily takes place during the first ten years of life. During puberty, the rest of the body grows rapidly, causing the head-to-body ratio to decrease. The circumference of the head of a 1-year-old infant is approximately 84% of that in adults. The corresponding percentage for a 7-year-old is 93–95% [Prader et al., 1988]. This growth mainly takes place in the skull and brain. Structures such as the internal parts of the auditory organ and the eyes do not grow after birth [Eisenberg, 1976]. The thickness of the cranial bones increases in a virtually linear fashion during the first 12 years after birth from an average of 1.4 mm at birth to 6.8 mm at 12 years of age [Koenig et al., 1995]. Growth then decelerates before coming to a stop at around 18 years of age with an average cranial bone thickness of 7.7 mm. The water and ion level in the cranial bones, and thus permittivity and conductivity, decreases during this period, due to progressive calcification. As a result, one would anticipate a higher electromagnetic barrier function of the cranial bones for children compared to adults. It is noted that the SAR distribution in the head results from a complex electromagnetic interaction in which the thickness and the electromagnetic barrier function of the cranial bones are only two of many factors.

During the first year of life, brain growth is the result of an increase both in the number of brain cells, and in their weight [Fein, 1978]. After this time, only the weight of the cells increases. Myelination of the brain chiefly occurs in the first 2 years of life [Holland et al., 1986; Van der Knaap and Valk, 1995]. Unlike intercellular fluid, myelin does not contain free ions. This means that if the amount of myelin in the brain increases, this will result in a reduction of the ion concentration and consequently a reduction of the overall electrical conductivity of brain tissue. This occurs during early development, but there is very little change thereafter. There is no data available on the effects of exposure to RF electromagnetic fields on neurogenesis.

A recent publication describes measured changes in the dielectric properties of various tissues in the rat, from birth up to an age of 70 days [Peyman et al., 2001]. The conductivity of both cerebral tissue and the cranium decreases continuously over that period. However, how and whether these data can be extrapolated to humans is unclear. The development of the head and brain of rats and humans follows a different time pattern. The developmental stage at birth is different, and it is not clear to what human developmental stage that of a 70 day old rat compares.

There have been several model-based studies that compare the effects of exposure to the electromagnetic fields emitted by a mobile telephone antenna in adults and children. One that has not actually been quoted in the IEGMP report, but was referred to later to support the statement that the deposition of electromagnetic energy in children's heads is higher than that in adults, is the publication of Gandhi et al. [1996]. However,

Schönborn et al. [1998] demonstrated Gandhi's conclusions to be not correct. They calculated the SAR for three different models of the head, namely for an adult, a 3 year old and a 7 year old child. These models were obtained from actual MRI scans. Gandhi et al. [1996] also calculated SAR's for these ages, but their models for children's heads were scaled down from an adult one. Consequently, the proportions and tissue distributions were incorrect. The calculations of Schönborn et al. [1998] showed that no difference exists between their three models in terms of absorption of electromagnetic fields. Except that, given the somewhat smaller dimensions of the children's heads, the mean quantity of absorbed energy per unit volume is somewhat higher than for an adult. However, these calculations use the same dielectric parameters for all ages. The effect of using an age-dependent magnitude for these parameters is unknown, assuming that they undergo significant changes between the age of 3 and adulthood. Moreover, it has been shown that current model calculations are associated with uncertainties of up to 30% for 10 g average SAR values [Nikita et al., 2000]. It is expected that effects of age related changes in dielectric parameters, if any, fall within this uncertainty. In order to allow correct interpretation, model studies should always identify and take into account the inherent uncertainties.

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

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