Are Children at Increased Risk of Health Effects from Exposure to Radiation from Mobile Communication Devices?

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In 2005 an independent expert group from the British National Radiation Protection Board discouraged the use of mobile phones by children and gave advice to parents to restrict use of mobile phones of their children. Similar warnings were issued by other groups. In contrast, the Health Council of The Netherlands stated in 2003: *"…the committee feels that there are no health-based reasons for limiting the use of mobile phones by children."*
J. Grigoriev, chairman of the Russian Committee for Non-Ionizing Radiation Protection, responded:

"... in my opinion the conclusion ... on the absence of necessity to restrict using of cellular phones by children was ill founded. A one-sided analysis of the problem was made, using only a physical approach and not taking into account world-wide experience of monitoring and investigations of physiologists, psychologists, morphologists, pediatricians, and other specialists and fields." (Grigoriev, 2004).

Hence there is no agreement about whether there is an increased risk or a risk at all for children. The related chain of arguments can be exemplified by the procedure of the Health Council of The Netherlands (Fig.1).

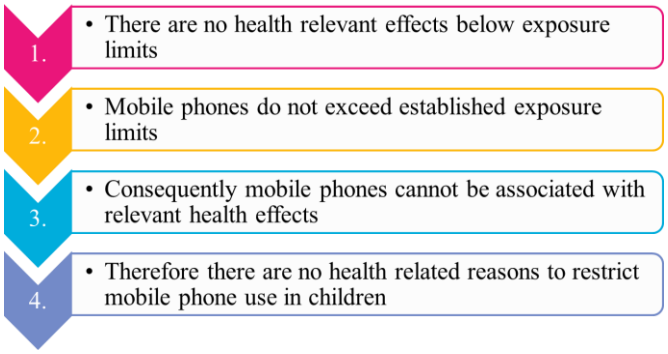

Figure 1: Chain of arguments by the Health Councils of The Netherlands concerning health risks of mobile phones in children

Telecommunication industry and numerous expert groups express the opinion that there are no health relevant effects below limit values. Such exposure limits are either 'basic restrictions', defined in terms of specific absorption rates – SAR – or 'reference levels' specified as field strengths or flux densities, and are derived from the immediate effects of a radiation induced increase of body temperature. It is not denied that effects also occur in the low-dose range below guideline levels. However it is disputed such effects could be of health relevance.

This chain of arguments collapses if long-term effects of mobile phone use can be demonstrated that are of immediate health implication as, for example, an increased risk for brain tumors. Therefore, these groups are predominantly concerned with criticism of investigations that are indicating such immediate health risks (like studies of the Hardell group and Interphone). In doing so, the consequences of potential biases that could have been operating in these studies are generally disregarded. If the criticism is taken seriously and it is investigated which effects on the risk estimates biases could have had, it turns out that the majority of these biases would rather lead to an underestimation of the true risk.

Based on the current state of knowledge we have to start from the assumption that exposure to electromagnetic fields (EMF) from mobile phones is associated with increased health risks. If this is the case the

questions arise: What is the nature of these increased risks? What is the risk of children as compared to adults? How can the risk be managed in a responsible ways?

Background

In 1993/94 when digital mobile telecommunication was introduced, nobody would have predicted the secular success of this technology leading to an almost 100% use a few years later. In most OECD countries a penetration rate of 100% was reached between 2000 and 2005 (see Fig.2). Because of the saturation of the market and the ongoing price fight the only perspective for the companies is extending the market to children and adolescents. In 2013 a research report for the GSM Association (Children's use of mobile phones. An international comparison 2012; published 2013 by the GSM Association) stated that even in developing countries such as Egypt and Indonesia, the majority of children have access to an own mobile phone and that it is predominantly a new phone and not a secondhand one from parents or siblings.

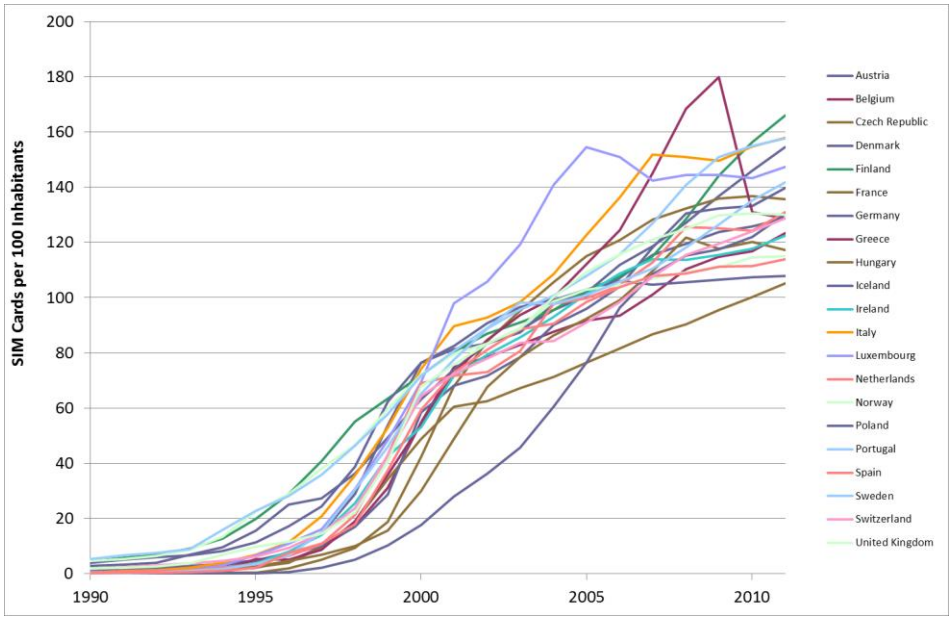

Figure 2: Penetration rate in % of inhabitants of OECD countries

Children and adolescents are not only important as future and present customers for the industry but also because of their technical interest and their so called technology literacy that is particularly advantageous for the future development and implementation of new telecommunication technologies.

In the last years the proportion of children and adolescents using a mobile phone has dramatically increased (Söderqvist et al. 2007). Also intensity of use has increase. Hence the question arises how health protection can be promoted under these conditions.

Scientific basis

Children are not small adults! There are not only size differences between heads of children and adults. There are also differences in morphology and composition of tissues. These differences decline with increasing age, but the rate of change is different for the different components. While the thickness of the skull at about 10 years almost reaches that of an adult, head circumference after a strong increase during the first years of life slowly approaches that of an adult increasing beyond age 20 (Fig.3).

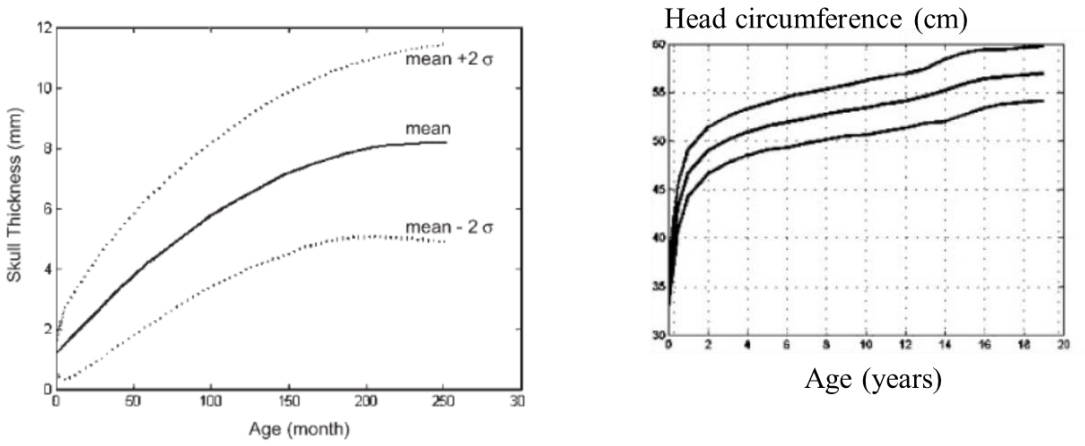

Figure 3: Development of skull thickness and head circumference with age

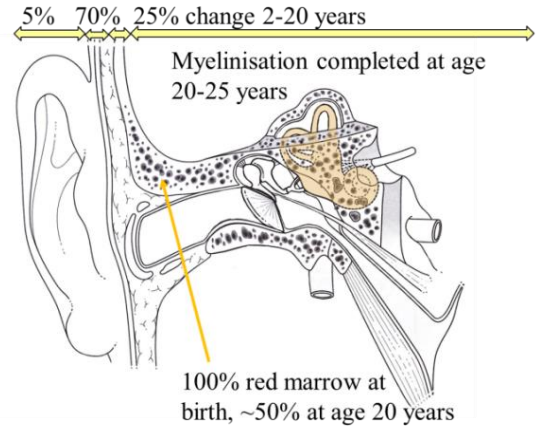

Figure 4: Changes of structures and tissues of the head from birth to adulthood

The relative changes of the tissues of the head during childhood are not uniform, which explains the morphological differences between a child's head and an adult's head. Among the changes of tissues especially the development of neuroglia, the process of myelination that extends to the mid-twenties and the decline in hematopoietic red marrow in the bones of the head are of importance. As a consequence of these changes it follows that children absorb considerably more EMF radiation in vulnerable tissues of the head as compared to adults. Furthermore, the relative penetration depth is larger (Christ et al. 2010; de Salles et al. 2006; Ghandi et al. 2012).

In summary:

- Children have softer pinna, thinner scalp and skull, therefore, penetration depth of EMF from mobile phones is larger;
- Myelination is not yet completed, therefore, a higher SAR is expected in developing tissues of the brain;
- Hematopoietic bone marrow declines in the bones of the head, therefore, higher SAR within the head bones the younger the child.

Possible consequences of exposure in children and adolescents

A large investigation of effects of mobile phone use of mothers during pregnancy and after birth has been published by Divan et al. (2008, 2012). Such exposure was associated with conduct problems many years later (Fig.5).

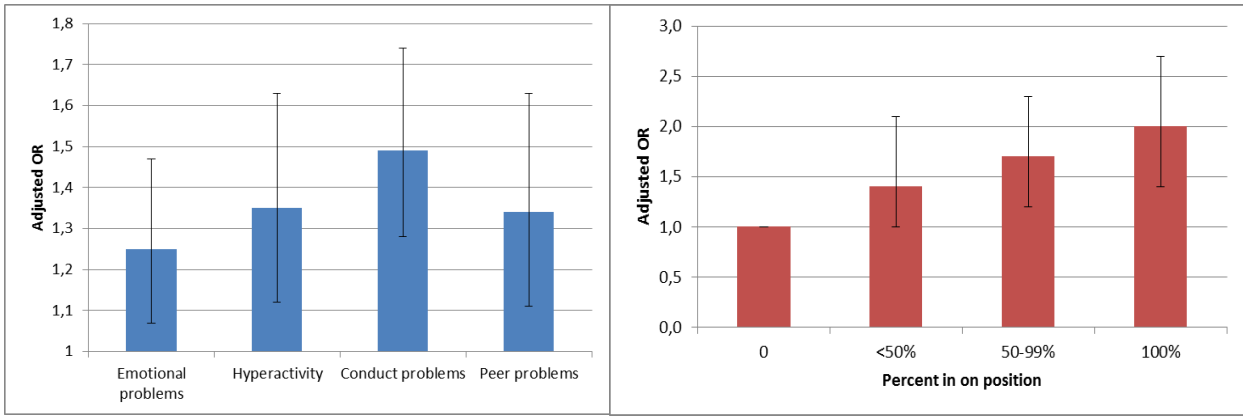

Figure 5: Adjusted Odds-Ratio (as an indicator of relative risk) related to different behavioral problems of children of mothers using a mobile phone pre- and post partum (left Divan et al. 2008); right: dependency of behavioral problems on the rate the phone was in on position while the mother carried the phone close to the body (Divan et al. 2012)

A similar investigation of effects of mobile phone use during pregnancy on later problems in children (Sudan et al. 2012) found an increased risk for headaches depending on the amount of mobile phone use of the mother (Fig.6).

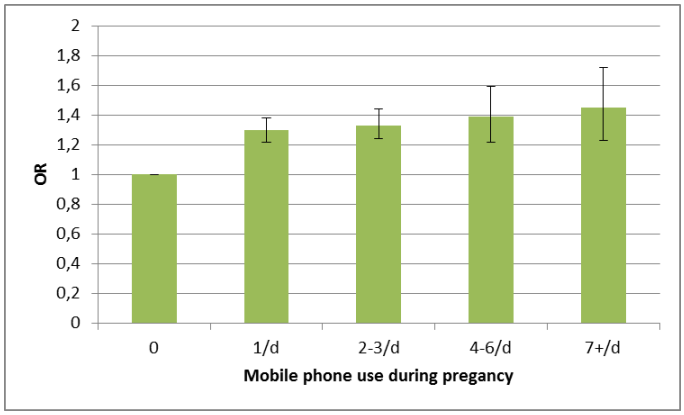

Figure 6: Odds-Ratio (as an indicator of relative risk) for headaches in the child depending in the amount of mobile phone use of the mother during pregnancy (Sudan et al. 2012)

Concerning the risk on health of own mobile phone use of children there are only a few investigations. One of these studies addressed the issue whether mobile phone use could be a risk factor for ADHD (attention deficit hyperactivity disorder) (Byun et al. 2012). This investigation found an interaction effect of mobile phone use and lead exposure (Fig. 7).

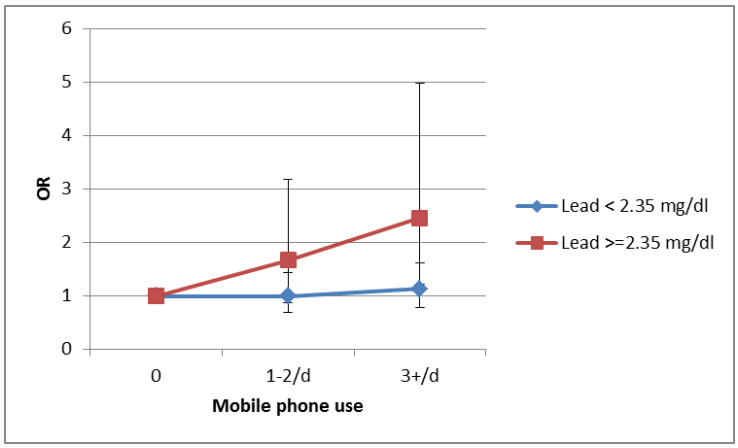

Figure 7: Odds-Ratio (as an indicator of relative risk) for ADHS depending on the amount of mobile phone use and blood lead levels (Byun et al.2012)

Thomas et al. (2010) investigated in the context of the German Mobile Telecommunication Research Program behavioral problems in children and adolescents in relation to exposure to mobile telecommunication EMFs measured by personal dosimetry. The risk of behavioral problems increased with increasing exposure (Fig.8).

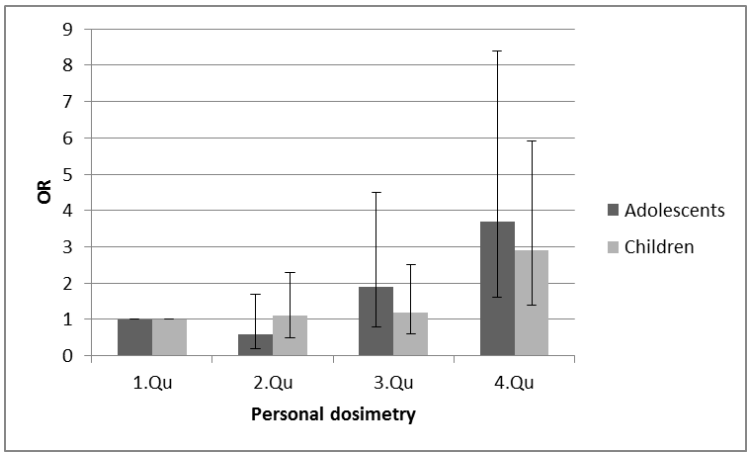

Figure 8: Odds-Ratio (as an indicator of relative risk) for behavioral problems in children and adolescents depending on the intensity of exposure (measured by personal dosimetry and grouped by quartiles) (Thomas et al. 2010)

The only investigation about brain tumors in children and adolescents in relation to mobile phone use published so far was the CEFALO study a multinational study published in the Journal of the National Cancer Institute in 2011 (Aydin et al. 2011).

In the press release accompanying the publication it was stated:

"Reassuring results from first study on young mobile users and cancer risk: An international network of scientists, including researchers from Karolinska Institutet, has now published the first study on possible brain tumor risk and use of mobile phones among children and adolescents. The so called CEFALO study does not show an increased brain tumor risk for young mobile users."

In contrast to this view expressed by the study authors, the results are indeed alarming. Despite the short duration of mobile phone use in the majority of children and adolescents in this investigation there was a significantly elevated risk already at durations of more than 2.8 years as assessed by records of operators.

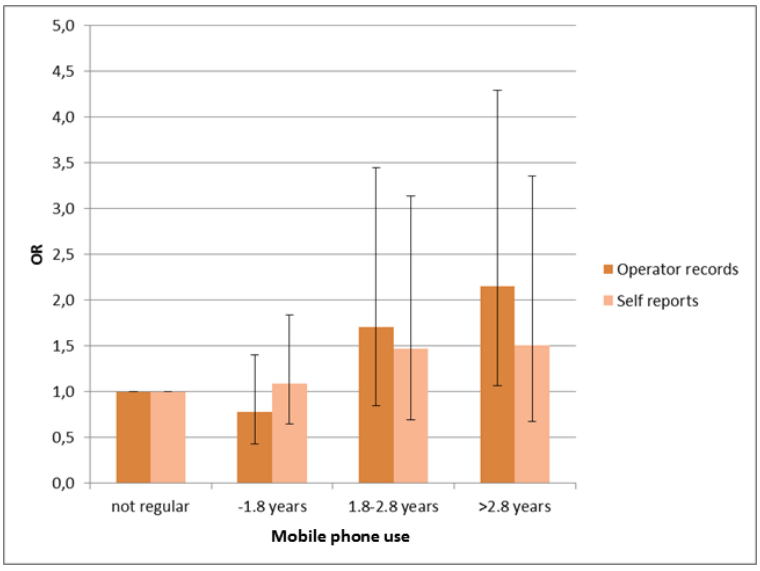

Figure 9: Odds-Ratio (as an indicator of relative risk) for brain tumors in children and adolescents (7-19 years of age) depending on the duration of mobile phone use (CEFALO-Study, Ajdin et al.2011)

Fundamental considerations

In general, we have to start from the assumption that developing tissue is more vulnerable to toxic exposures. Dosimetry provides evidence that especially those parts of the central nervous system that are still developing absorb a greater proportion of electromagnetic energy. Hence there is a possibility that only for this reason children are at greater risk from mobile phone use and exposure to similar electromagnetic fields.

Because of anatomical and tissue properties of children's skulls the distribution of absorption and hence exposure in the brain is different resulting in a higher SAR in some but not all parts of the brain as compared to adults. Hence there is a qualitative and quantitative difference in exposure of the brain between children and adults.

Due to the larger proportion of red marrow in the bones of the head, a higher absorption of EMF energy will occur in the bones with potential negative effects on hematopoiesis.

It must also be recognized that if exposure starts early in life a higher cumulative dose can occur during lifetime. If EMFs have cumulative effects for which there is evidence from epidemiology then exposure already during childhood would be associated with an increased lifetime risk.

For these reasons it is adequate to recommend caution for the use of mobile telecommunication by children and adolescents. Even more than for adults the recommendations for reduction of exposure to radiation from mobile phones should be observed by children and adolescents.

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