

Review

Estimating the risk of brain tumors from cellphone use: Published case–control studies

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Abstract

This paper reviews the results of early cellphone studies, where exposure duration was too short to expect tumorigenesis, as well as two sets of more recent studies with longer exposure duration: the Interphone studies and the Swedish studies led by Dr. Lennart Hardell. The recent studies reach very different conclusions. With four exceptions the industry-funded Interphone studies found no increased risk of brain tumors from cellphone use, while the Swedish studies, independent of industry funding, reported numerous findings of significant increased brain tumor risk from cellphone and cordless phone use. An analysis of the data from the Interphone studies suggests that either the use of a cellphone *protects* the user from a brain tumor, or the studies had serious design flaws. Eleven flaws are identified: (1) selection bias, (2) insufficient latency time, (3) definition of ‘regular’ cellphone user, (4) exclusion of young adults and children, (5) brain tumor risk from cellphones radiating higher power levels in rural areas were not investigated, (6) exposure to other transmitting sources are excluded, (7) exclusion of brain tumor types, (8) tumors outside the cellphone radiation plume are treated as exposed, (9) exclusion of brain tumor cases because of death or illness, (10) recall accuracy of cellphone use, and (11) funding bias. The Interphone studies have all 11 flaws, and the Swedish studies have 3 flaws (8, 9 and 10). The data from the Swedish studies are consistent with what would be expected if cellphone use were a risk for brain tumors, while the Interphone studies data are incredulous. If a risk does exist, the public health cost will be large. These are the circumstances where application of the Precautionary Principle is indicated, especially if low-cost options could reduce the absorbed cellphone radiation by several orders of magnitude.

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1. Introduction

This review covers all case–control studies on the risk of brain tumors from cellphone use published up to March 2009 and does not include epidemiological studies on the risk of brain tumors from exposure to other sources of electromagnetic fields (EMFs). It examines the strengths and weaknesses of these studies and what can be learned from differences in the findings. Because certainty is not possible in science, much less in epidemiology, the indication of a possible risk of brain tumors from cellphone use suggests that the Precautionary Principle be applied.

In almost all epidemiological investigations of rare diseases, such as brain tumors, researchers use what is known as a case–control design. Cases are subjects who have the disease and controls are randomly chosen subjects without the disease. Typically controls are matched to the cases by age, gender, geographical area, and income. Subjects are asked a set of questions, which for a cellphone study would include questions about their cellphone use.

The Odds Ratio (OR), the increased risk ($OR > 1.0$), or decreased risk ($OR < 1.0$) of brain tumors as a result of exposure to cellphone radiation is reported. A two-by-two table is used to calculate the Odds Ratio. In Table 1, Case and Control subjects are in the rows and Exposed and Unexposed subjects are in the columns. The Odds Ratio = $(\text{Exposed Cases}) \times (\text{Unexposed Controls}) / (\text{Exposed Controls}) \times (\text{Unexposed Cases})$.

Actual studies use sophisticated statistical regression analysis to adjust for confounding effects (age, gender, smoking, etc.), but the basic concept is the same. Additionally, along with the Odds Ratio, a 95% confidence interval (CI) is reported.

In this discussion cellphone studies are grouped into early studies and later studies. The later studies are presented as

two sets of studies. Since each set uses a common protocol, each can be considered a single study: The two sets are the industry-funded Interphone studies and the independently funded Swedish studies led by Dr. Lennart Hardell.

2. Early case–control cellphone studies

The salient fact of these early studies is the short duration of cellphone use. It would have been surprising to find any risk of a brain tumor, because an increased risk would have required a short latency time between exposure and diagnosis. Indeed, none of these studies reported finding a significant risk ($p \leq 0.05$) of a brain tumor from cellphone use. Yet, as can be seen in Table 2, each study did find a non-significant ($p > 0.05$) increased risk including two near-significant findings of increased risk ($p < 0.10$). And, Auvinen et al. found that for each year of cellphone use a significant 20% increased risk of a brain cancer (glioma). Table 2 summarizes these studies [1–5].

Perhaps these early studies that found no significant risk had actually found an early warning of trouble ahead.

3. The industry-funded Interphone study

The Interphone study is a 13-country case–control study on the risk of brain and salivary gland tumors from cellphone use. The Interphone study uses a standard protocol such that all individual country results can be pooled together to increase the power of the study. This discussion is limited to the brain tumors studies.

As of December 2008 there have been 11 single-country and 3 multi-country Interphone brain tumor studies published [6–19]. The multi-country studies will not be discussed

Table 1
Simple example of increased risk.

	Exposed	Unexposed	Totals
Cases	60	40	100
Controls	49	51	100
Totals	109	91	200
Odds Ratio	1.56		

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