Statements from Governments and Expert Panels

Concerning Health Effects and Safe Exposure Levels of Radiofrequency Energy

(After IARC classification announcement on May 31, 2011)

July 5, 2011

2011
WHO International Agency for Research on Cancer Monograph Working Group (IARC)
RF-EMF Monograph Working Group (IARC)
Carcinogenicity of radiofrequency electromagnetic fields - Robert Baan, Yann Grosse, Béatrice Lauby-Secretan, Fatiha El Ghissassi, Véronique Bouvard, Lamia Benbrahim-Tallaa, Neela Guha, Farhad Islami, Laurent Galichet, Kurt Straif, on behalf of the WHO International Agency for Research on Cancer Monograph Working Group
http://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(11)70147-4/fulltext
Page 2: *The Working Group concluded that there is "limited evidence" in human beings for the carcinogenicity of RF-EMF, based on positive associations between glioma and acoustic neuroma and exposure to RF-EMF from wireless phones.* *A few members of the Working Group considered the current evidence in humans "inadequate", therefore no conclusion about a causal association was reached.* *Overall, the Working Group concluded that there is "limited evidence" in experimental animals for the carcinogenicity of RF-EMF.* *In view of the limited evidence in humans and in experimental animals, the Working Group classified RF-EMF as "possibly carcinogenic to humans" (Group 2B). This evaluation was supported by a large majority of Working Group members.*

1. **ICNIRP (2011)**
   Note From The ICNIRP Regarding The IARC Classification Of Radiofrequency Fields
   http://www.icnirp.de/documents/ICNIRP_IARCclassificationRF.pdf
   - "ICNIRP awaits with interest the full Monograph that explains the justification and arguments put forward by IARC in arriving at this conclusion. ICNIRP has been conducting a review of the potential health effects of RF including carcinogenicity as well as other aspects. The Commission will be publishing a revision of the ICNIRP guidelines on limiting RF exposure for the general public and occupational groups. It will take into account all aspects of the literature including the material put forward in the IARC Monograph."

2. **WHO (June 22, 2011)**
   Fact Sheet #193 Electromagnetic fields and public health: mobile phones
   http://www.who.int/mediacentre/factsheets/fs193/en/index.html
   Are there any health effects?
   - "A large number of studies have been performed over the last two decades to assess whether mobile phones pose a potential health risk. To date, no adverse health effects have been established as being caused by mobile phone use."
   - "WHO will conduct a formal risk assessment of all studied health outcomes from radiofrequency fields exposure by 2012."

3. **American Cancer Society (2011)**
   http://pressroom.cancer.org/index.php?s=43&item=312
   Dr. Otis Brawley, Chief Medical Director, responds to IARC Classification of Cell Phones as Possible Carcinogenic
   - "It is critical that its findings be interpreted with great care. The working group reviewed a large number of studies and concluded that there was limited evidence that cell phones may cause glioma, a type of brain tumor that starts in the brain or spine. A 2B classification means that there could be some risk, but that the evidence is not strong enough to be considered causal, and needs to be investigated further. The bottom line is the evidence is enough to warrant concern, but it is not conclusive."
   - "It's also important to put this 2B classification into perspective. Many common exposures are classified in Category 2B, including gasoline exhaust and even coffee."

4. **US National Cancer Institute (2011)**
   http://www.cancer.gov/newscenter/pressreleases/2011/IARCcellphoneMay2011
   NCI Statement: International Agency for Research on Cancer Classification of Cell Phones as "Possible Carcinogen"
   - "Interphone, considered the major study on cell phone use and cancer risk, has reported that overall, cell phone users have no increased risk of the most common forms of brain tumors -- glioma and meningioma. In addition, the study revealed no evidence of increasing risk with progressively increasing number of calls, longer call time, or years since beginning cell phone use. For the small proportion of study participants who reported spending the most total time on cell phone calls, there was

some increased risk of glioma, but the researchers considered this finding inconclusive. Furthermore, a large population-based cohort study in Denmark has found no evidence of increased risk of brain tumors. It is noteworthy that brain cancer incidence and mortality rates in the population have changed little in the past decade."

http://www.cancer.gov/ncicancerbulletin/062811/page4
NCI Cancer Bulletin: Dr. Martha Linet on Cell Phone Use and Cancer Risk

- "Most studies to date have not found an association between cell phone use overall and the development of tumors. However, there are a handful of studies that have shown an association with increased risk for glioma among the small number of cell phone users who reported the highest level of call time. Among the positive studies, results are conflicting and don't show a dose-response. In addition, there is no biologically plausible mechanism or animal evidence for how cell phones might cause cancer."

5. **UK Health Protection Agency (2011)**
   http://www.hpa.org.uk/NewsCentre/NationalPressReleases/2011PressReleases/110531electomagneticfields/
   - "HPA advice is that there is no clear scientific evidence of a cancer risk from exposure to radiofrequencies at levels below international guidelines but the possibility remains."

6. **UK National Health Service (2011)**
   http://www.nhs.uk/news/2011/05May/Pages/iarc-mobile-phones-brain-tumour-cancer.aspx
   So do mobile phones definitely cause cancer?
   - No. The IARC's classification means there is some evidence linking mobile phones to some types of brain cancer but that this evidence is too weak to draw strong conclusions.

7. **Australian Radiation Protection and Nuclear Safety Agency (ARPANSA, 2011)**
   Statement by ARPANSA on IARC announcement on classification of radiofrequency
   http://www.arpansa.gov.au/news/MediaReleases/mr1_030611.cfm
   - "ARPANSA does not consider that the new classification should give rise to any alarm."
   - "ARPANSA will consider the implications of the IARC decision and the underlying scientific evidence and, if necessary, review the current standard and other means of protecting the public."

8. **Cancer Council Australia (2011)**
   http://www.cancer.org.au/Newsmedia/mediareleases/mediareleases2011/1June2011.htm
   - "However, these findings need to be put in context. While we need to continue researching the possible link between mobile phones and cancer, it is important to remind people there are many more established cancer risk factors that we can take

action every day. Strong action on clear cancer risks like tobacco, alcohol, excessive UV exposure and obesity remain a priority."

9. **Association for International Cancer Research (2011)**
   http://www.thecourier.co.uk/Community/Health/article/14539/cancer-expert-plays-down-mobile-phone-link-with-brain-tumours.html
   - "There is no convincing evidence linking mobile phone use and cancer."

10. **Irish Cancer Society**
    http://www.cancer.ie/news/news.php?newsID=464?h
    - "This means that there is potential for harm from mobile phones but there is insufficient evidence to say there is a direct effect. "

11. **Health Canada (2011)**
    http://www.canada.com/health/Call+concern+cellphone+emissions+carcinogenic+says/4868280/story.html#ixzz1NyKX64T5
    James McNamee, a research scientist at Health Canada's electromagnetics division and member of IARC's working group
    - "The best way to define this is it's a recognition that there is some evidence from human studies and from animal studies. It's very important to state that this evidence is far from established and it's far from causal, but it is a recognition that a lot of work has been done, a great deal of work has been reviewed and it's a statement of where the science is in time."

12. **ICNIRP (July 2011)**
    Mobile Phones, Brain Tumours and the Interphone Study: Where Are We Now?

    http://ehp03.niehs.nih.gov/article/info%3Adoi%2F10.1289%2Fehp.1103693

    - "In summary, Interphone and the literature overall have methodological deficiencies but do not demonstrate greater risk of either glioma or meningioma with longer or greater use of mobile phones, although the longest period since first use examined is <15 years."
    - "Although there remains some uncertainty, the trend in the accumulating evidence is increasingly against the hypothesis that mobile phone use can cause brain tumours in adults."

NOTE

NOTE FROM THE INTERNATIONAL COMMISSION ON NON-IONIZING RADIATION PROTECTION (ICNIRP) REGARDING THE IARC CLASSIFICATION OF RADIOFREQUENCY FIELDS

Munich, 31.05.2011

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) notes the publication of the International Agency for Research on Cancer (IARC) classification of radiofrequency fields (RF) as Group 2B on the IARC scale of carcinogenic risk to humans. ICNIRP awaits with interest the full Monograph that explains the justification and arguments put forward by IARC in arriving at this conclusion.

ICNIRP has been conducting a review of the potential health effects of RF including carcinogenicity as well as other aspects. The Commission will be publishing a revision of the ICNIRP guidelines on limiting RF exposure for the general public and occupational groups. It will take into account all aspects of the literature including the material put forward in the IARC Monograph.

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Electromagnetic fields and public health: mobile phones

Fact sheet N°193
June 2011

Key facts

- Mobile phone use is ubiquitous with an estimated 4.6 billion subscriptions globally.
- The electromagnetic fields produced by mobile phones are classified by the International Agency for Research on Cancer as possibly carcinogenic to humans.
- Studies are ongoing to more fully assess potential long-term effects of mobile phone use.
- WHO will conduct a formal risk assessment of all studied health outcomes from radiofrequency fields exposure by 2012.

Mobile or cellular phones are now an integral part of modern telecommunications. In many countries, over half the population use mobile phones and the market is growing rapidly. At the end of 2009, there were an estimated 4.6 billion subscriptions globally. In some parts of the world, mobile phones are the most reliable or the only phones available.

Given the large number of mobile phone users, it is important to investigate, understand and monitor any potential public health impact.

Mobile phones communicate by transmitting radio waves through a network of fixed antennas called base stations. Radiofrequency waves are electromagnetic fields, and unlike ionizing radiation such as X-rays or gamma rays, can neither break chemical bonds nor cause ionization in the human body.

Exposure levels

Mobile phones are low-powered radiofrequency transmitters, operating at frequencies between 450 and 2700 MHz with peak powers in the range of 0.1 to 2 watts. The handset only transmits power when it is turned on. The power (and hence the radiofrequency exposure to a user) falls off rapidly with increasing distance from the handset. A person using a mobile phone 30–40 cm away from their body – for example when text messaging, accessing the

Internet, or using a “hands free” device – will therefore have a much lower exposure to radiofrequency fields than someone holding the handset against their head.

In addition to using "hands-free" devices, which keep mobile phones away from the head and body during phone calls, exposure is also reduced by limiting the number and length of calls. Using the phone in areas of good reception also decreases exposure as it allows the phone to transmit at reduced power. The use of commercial devices for reducing radiofrequency field exposure has not been shown to be effective.

Mobile phones are often prohibited in hospitals and on airplanes, as the radiofrequency signals may interfere with certain electro-medical devices and navigation systems.

Are there any health effects?

A large number of studies have been performed over the last two decades to assess whether mobile phones pose a potential health risk. To date, no adverse health effects have been established as being caused by mobile phone use.

Short-term effects

Tissue heating is the principal mechanism of interaction between radiofrequency energy and the human body. At the frequencies used by mobile phones, most of the energy is absorbed by the skin and other superficial tissues, resulting in negligible temperature rise in the brain or any other organs of the body.

A number of studies have investigated the effects of radiofrequency fields on brain electrical activity, cognitive function, sleep, heart rate and blood pressure in volunteers. To date, research does not suggest any consistent evidence of adverse health effects from exposure to radiofrequency fields at levels below those that cause tissue heating. Further, research has not been able to provide support for a causal relationship between exposure to electromagnetic fields and self-reported symptoms, or “electromagnetic hypersensitivity”.

Long-term effects

Epidemiological research examining potential long-term risks from radiofrequency exposure has mostly looked for an association between brain tumours and mobile phone use. However, because many cancers are not detectable until many years after the interactions that led to the tumour, and since mobile phones were not widely used until the early 1990s, epidemiological studies at present can only assess those cancers that become evident within shorter time periods. However, results of animal studies consistently show no increased cancer risk for long-term exposure to radiofrequency fields.

Several large multinational epidemiological studies have been completed or are ongoing, including case-control studies and prospective cohort studies examining a number of health endpoints in adults. The largest retrospective case-control study to date on adults, Interphone, coordinated by the International Agency for Research on Cancer (IARC), was designed to determine whether there are links between use of mobile phones and head and neck cancers in adults. The international pooled analysis of data gathered from 13 participating countries found no increased risk of glioma or meningioma with mobile phone use of more than 10 years. There are some indications of an increased risk of glioma for those who reported the highest 10% of cumulative hours of cell phone use, although there was no consistent trend of

increasing risk with greater duration of use. The researchers concluded that biases and errors limit the strength of these conclusions and prevent a causal interpretation. Based largely on these data, IARC has classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), a category used when a causal association is considered credible, but when chance, bias or confounding cannot be ruled out with reasonable confidence.

While an increased risk of brain tumors is not established, the increasing use of mobile phones and the lack of data for mobile phone use over time periods longer than 15 years warrant further research of mobile phone use and brain cancer risk. In particular, with the recent popularity of mobile phone use among younger people, and therefore a potentially longer lifetime of exposure, WHO has promoted further research on this group. Several studies investigating potential health effects in children and adolescents are underway.

Exposure limit guidelines

Radiofrequency exposure limits for mobile phone users are given in terms of Specific Absorption Rate (SAR) – the rate of radiofrequency energy absorption per unit mass of the body. Currently, two international bodies [1, 2] have developed exposure guidelines for workers and for the general public, except patients undergoing medical diagnosis or treatment. These guidelines are based on a detailed assessment of the available scientific evidence.

WHO'S response

In response to public and governmental concern, WHO established the International Electromagnetic Fields (EMF) Project in 1996 to assess the scientific evidence of possible adverse health effects from electromagnetic fields. WHO will conduct a formal risk assessment of all studied health outcomes from radiofrequency fields exposure by 2012. In addition, and as noted above, the International Agency for Research on Cancer (IARC), a WHO specialized agency, has reviewed the carcinogenic potential of radiofrequency fields, as from mobile phones in May 2011.

WHO also identifies and promotes research priorities for radiofrequency fields and health to fill gaps in knowledge through its research agendas.

WHO develops public information materials and promotes dialogue among scientists, governments, industry and the public to raise the level of understanding about potential adverse health risks of mobile phones.

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[1] International Commission on Non-Ionizing Radiation Protection (ICNIRP). *Statement on the "Guidelines for limiting exposure to time-varying electric, magnetic and electromagetic fields (up to 300 GHz)"*, 2009.

[2] Institute of Electrical and Electronics Engineers (IEEE). *IEEE standard for safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz*, IEEE Std C95.1, 2005.

Press Releases

Otis Brawley responds to IARC Classification of Cell Phones as Possible Carcinogenic

Below are comments from Otis W. Brawley, M.D., American Cancer Society chief medical officer, in response to the the WHO/International Agency for Research on Cancer (IARC) classification of radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B).

"This report comes from a very credible group, and reaches reasonable conclusions about electromagnetic radiation from cellphones and other devices. It is critical that its findings be interpreted with great care. The working group reviewed a large number of studies and concluded that there was limited evidence that cell phones may cause glioma, a type of brain tumor that starts in the brain or spine. A 2B classification means that there could be some risk, but that the evidence is not strong enough to be considered causal, and needs to be investigated further. The bottom line is the evidence is enough to warrant concern, but it is not conclusive.

"The American Cancer Society does not independently judge the carcinogenicity of different exposures. Instead, we rely on IARC reviews of available evidence for our recommendations. At first glance, these new recommendations are very much in line with the American Cancer Society's current information that the evidence is limited, that further research is needed, and that there are things people who are concerned about radiofrequency exposure can do to limit their exposure, including using an ear piece and limiting cell phone use, particularly among children.

"Given that the evidence remains uncertain, it is up to each individual to determine what changes they wish to make, if any, after weighing the potential benefits and risks of using a cell phone. If some feel the potential risk outweighs the benefit, they can take actions, including limiting cell phone use, or using a headset. Limiting use among children also seems reasonable in light of this uncertainty. On the other hand, if someone is of the opinion that the absence of strong scientific evidence on the harms of cell phone use is reassuring, they may take different actions, and it would be hard to criticize that.

"It's also important to put this 2B classification into perspective. Many common exposures are classified in Category 2B, including gasoline exhaust and even coffee.

For more information, see: "**Cellular Phones**."

Also see **Dr. Len's Cancer Blog**.

http://www.cancer.gov/newscenter/pressreleases/2011/IARCcellphoneMay2011

National Cancer Institute
at the National Institutes of Health

Posted: 05/31/2011

NCI Statement: International Agency for Research on Cancer Classification of Cell Phones as "Possible Carcinogen"

The World Health Organization's International Agency for Research on Cancer (IARC) today classified mobile phone use and other radiofrequency electromagnetic fields as a possible carcinogen (group 2B). This is neither new research nor at odds with previous findings.

Both IARC and NCI recommend continued monitoring of both brain cancer trends and new evidence from studies in humans and laboratory animals. In particular, it will be important to assess risk after long-term use, and for younger users. IARC further recommends specific actions to reduce exposure (e.g. hands-free use and texting) as further studies are undertaken.

Interphone, considered the major study on cell phone use and cancer risk, has reported that overall, cell phone users have no increased risk of the most common forms of brain tumors -- glioma and meningioma. In addition, the study revealed no evidence of increasing risk with progressively increasing number of calls, longer call time, or years since beginning cell phone use. For the small proportion of study participants who reported spending the most total time on cell phone calls, there was some increased risk of glioma, but the researchers considered this finding inconclusive. Furthermore, a large population-based cohort study in Denmark has found no evidence of increased risk of brain tumors. It is noteworthy that brain cancer incidence and mortality rates in the population have changed little in the past decade.

The National Toxicology Program (NTP) at the National Institute of Environmental Health Sciences is leading the largest laboratory rodent study to date on cell phone radiofrequency exposures. The NTP studies will assess the potential for health hazards from exposure to cell phone radiation. The studies are designed to mimic human exposure and are based on the frequencies and modulations currently in use in the United States.

http://www.cancer.gov/ncicancerbulletin/062811/page4

Dr. Martha Linet on Cell Phone Use and Cancer Risk

The International Agency for Research on Cancer (IARC) published a synopsis of its forthcoming Monograph on the Evaluation of Carcinogenic Risks to Humans *online June 22 in* Lancet Oncology. *The monograph classifies exposure to mobile phones as "possibly carcinogenic to humans." Dr. Martha Linet, chief of the Radiation Epidemiology Branch in NCI's Division of Cancer Epidemiology and Genetics, discusses the IARC working group's decision and summarizes some of the ongoing research on mobile phones and cancer risk.*

Is there evidence of an increased risk of cancer from mobile phone use?

Most studies to date have not found an association between cell phone use overall and the development of tumors. However, there are a handful of studies that have shown an association with increased risk for glioma among the small number of cell phone users who reported the highest level of call time. Among the positive studies, results are conflicting and don't show a dose-response. In addition, there is no biologically plausible mechanism or animal evidence for how cell phones might cause cancer.

Why are there inconsistencies among the studies?

Most of the studies are based on data from interviews about cell phone use patterns from brain tumor patients and control subjects. We know that this kind of self-reported data is not necessarily accurate. Patients may be more likely to over-report use than controls, or they may mis-recall on which side of their head they held their phone. Cell phone technology has changed dramatically over time, and the studies cover different periods. The way people use cell phones has also changed over time, which makes accurate recall more difficult.

In addition, none of the epidemiologic studies measure actual radiofrequency exposure to the brain; the exposure is estimated from interview data.

How has the epidemiology community responded to IARC's decision to classify mobile phones as "possibly carcinogenic to humans?"

There's been a lot of lively debate among epidemiologists and interest at epidemiologic meetings. We have identified some gaps in the research, which ongoing studies are attempting to address. The three major gaps are: none of the studies—including Interphone, a large international study on cell phone use of more than 5,000 patients in 13 countries who had either glioma or meningioma—have a large number of long-duration, heavy-intensity cell phone users. So, risks associated with high exposures are based on fairly small numbers.

Second, there are no published studies of cancer risk among people who began using phones as children or adolescents.

Third, the animal studies have been limited to date, but the National Toxicology Program has a very large, well controlled study of rodents under way, involving thousands of rodents. Results are expected in 2014.

Would you describe some of these forthcoming studies?

There is a large European study, involving mostly Nordic and northern European countries, called COSMOS, that is following 250,000 people 30 to 59 years of age with repeated interviews, comparisons with cell phone subscriber data, and periodic linkage with cancer registry data.

Studying Epidemiological Risk Factors of Meningioma

The Epidemiology and Genetics Research Program in NCI's Division of Cancer Control and Population Sciences is funding four population-based case-control studies of meningioma. Investigators are collecting information on potential risk factors, including cell phone use, from individuals diagnosed with intracranial meningioma and comparing them with control subjects matched by sex, ethnicity, geographic location, and age. These studies represent the first concentrated effort to examine environmental and genetic risk factors for meningioma.

There are several NCI-funded studies in the United States looking at cell phone and radiofrequency exposure and risk of meningioma and other brain tumors in different populations. (See the sidebar for more information.)

And there is another European-funded initiative called Mobi-Kids that is modeled after Interphone. Mobi-Kids is studying brain tumor risk associated with cell phone use among people 10 to 24 years of age.

What is the main takeaway from all this?

The IARC working group classified cell phone use as a possible carcinogen. If one keeps in mind that possible means "maybe," that fits with the positive reports but overall inconsistent data. The studies under way addressing key research gaps will provide important information that should clarify questions not addressed by the research to date, and it will be important to continue to monitor incidence trends in brain tumors.

The steps suggested by the Food and Drug Administration and the Federal Communications Commission to reduce exposure include reducing the length and number of calls made from cell phones, using landline phones instead of cell phones, and switching to a cell phone with a hands-free device.

Of course, one of the most important general safety recommendations is to not use cell phones while driving. (End)

http://www.hpa.org.uk/NewsCentre/NationalPressReleases/2011PressReleases/110531electomagneticfields/

International Agency for Cancer Research Classification of Radiofrequency Electromagnetic Fields

31 May 2011

The Health Protection Agency (HPA) notes the recent IARC classification of radio waves in Group 2B "*possibly carcinogenic*".

Radio waves are very common in the environment and are used in radio and television broadcasts, wireless computer networks, pagers, radar, and cordless and mobile phones. This last use leads to a higher exposure than other uses and is the reason for the IARC review.

Other agents classified by IARC in Group 2B "*possibly carcinogenic*" are magnetic fields from electricity, coffee, petrol exhaust fumes and being a print worker.

The HPA notes the conclusion that there could be some risk and that a close watch should be kept for a link between mobile phones and cancer risk. HPA supports the call for additional research into the long-term, heavy use of mobile phones.

The HPA carries out research and continually reviews research on the health effects of radio waves. The IARC classification is consistent with previous reviews of the science and advice from HPA regarding the use of mobile phones.

HPA advice is that there is no clear scientific evidence of a cancer risk from exposure to radiofrequencies at levels below international guidelines but the possibility remains. The HPA has always advocated some precaution in the use of mobile phones in case there are long term effects which are presently unknown. Given the possibility of long term cancer effects, excessive use of mobile phones by children should be discouraged.

HPA advice on the use of wireless networks in schools and elsewhere is also consistent with this classification. Exposures from Wi-Fi equipment are much less than from mobile phones, and are well within international guidelines, so there is no reason why schools and others should not continue to use the technology.

An independent advisory group to HPA is reviewing all the evidence for possible health effects from radio waves published since 2003. It is due to publish its findings in 2012.

HPA's advice is consistent with published scientific evidence and with recommendations from bodies such as the EU Scientific Committee on Emerging and Newly Identified Health Risks, the International Commission on Non-Ionizing Radiation Protection and the World Health Organization.

Notes for editors

1. The International Agency for Research on Cancer is based in Lyon, France. The Agency's website is at http://www.iarc.fr/. Agents classified by IARC can be found at http://monographs.iarc.fr/ENG/Classification/index.php

2. Agents are selected for review by IARC on the basis of two main criteria: (a) there is evidence of human exposure and (b) there is some evidence or suspicion of carcinogenicity. The following topics are reviewed in depth; exposure data, studies of cancer in humans, studies of cancer in experimental animals and mechanistic and other relevant data.

For more information on mobile phones visit http://www.hpa.org.uk/Topics/Radiation/UnderstandingRadiation/UnderstandingRadiationTopics/ElectromagneticFields/MobilePhones/

Last reviewed: 31 May 2011

The classification does not mean mobiles definitely cause

http://www.nhs.uk/news/2011/05May/Pages/iarc-mobile-phones-brain-tumour-cancer.aspx

Mobile phones 'a possible carcinogen'

Wednesday June 1 2011

Several newspapers have today reported that mobile phones may cause cancer, with the *Daily Mail* saying that after years of contradictory claims health chiefs have finally delivered ‘an authoritative verdict’ on the matter.

The news comes after the International Agency for Research on Cancer (IARC), a division of the World Health Organization (WHO), classified mobile phone use as a possible cause of cancer. After examining a body of evidence on mobile phone use, the IARC yesterday announced it will now classify mobile phone signals as ‘possibly carcinogenic’ due to some study results suggesting a link to some types of brain cancers.

However, the classification means that the link is far from certain, with the IARC saying there is only ‘limited evidence’ of a link to brain tumours in humans, and that the results supporting a link may be due to other factors distorting study data. The IARC also said there is inadequate evidence to support a link to other cancer types.

Overall, this classification should not be taken to mean that there is a definite link between mobile phone use and cancer, only that some initial (possibly anomalous) study results have highlighted a relationship that needs further robust scientific investigation.

How are mobile phones now classified?

The IARC classifies different substances and exposures according to whether they are likely to cause cancer. The IARC had classified mobile phones as belonging to Group 2B on their scale, which means there is a possibility they cause cancer in humans.

Within the IARC scale, there are five categories of risk:

- **Group 1:** there’s extremely strong evidence that an agent causes cancer. Smoking and asbestos are in this category.
- **Group 2a:** an agent is ‘probably carcinogenic to humans’. The evidence in animal studies is 'sufficient' but 'limited' in humans.
- **Group 2b:** an agent is ‘possibly carcinogenic to humans’. There is limited evidence in humans that it causes cancer and the evidence from animal studies is ‘less than sufficient’. This is the new classification for mobile phones. Cancer Research UK consider Group 2B to mean that, ‘there is some evidence for a risk but it’s not that convincing’.
- **Group 3:** an agent is ‘not classifiable as to its carcinogencity to humans’. This means that the evidence is inadequate and limited in humans and animals.
- **Group 4:** an agent is probably not carcinogenic to humans.

What has prompted the classification?

The classification was based on an assessment of the potential carcinogenic hazards from mobile phones made at IARC meetings in May 2011. These were attended by a working group of 31 scientists from 14 countries that discussed and evaluated the evidence on any potential association between cancer and exposure to mobile phones, as well as other radio-frequency electromagnetic fields. This included examining the evidence for occupational exposure to radar and microwaves and environmental exposure associated with transmission of radio and TV signals.

They found that there was ‘limited evidence’ of an association between mobile phones and two types of brain cancer, glioma and acoustic neuroma. The IARC classified limited evidence as when there is a credible interpretation for an observed association between an exposure and cancer but that chance, bias or confounding cannot be ruled out with reasonable confidence.

For other types of cancers the IARC reported the available evidence as too ‘inadequate’ to draw any conclusions from, meaning that available human studies are of insufficient quality, consistency or statistical power to permit a conclusion, or that there are no studies in humans available.

Dr Jonathan Samet, chair of the IARC working group, commented, 'The conclusion means there could be some risk and therefore we need to keep a close watch for a link between cell phones and cancer risk.'

It is important that additional research be conducted into the long-term, heavy use of mobile phones, he added.

How big could the potential risk be?

The group did not quantify the potential risk but said that one study of past mobile phone use showed a 40% increased risk for glioma brain tumours among heavy users (with a reported average of 30 minutes daily over a 10-year period).

To put this 40% risk increase into context, the latest incidence figures from Cancer Research UK indicate that a man has a lifetime risk of developing a brain tumour (any type) of 1 in 133, and women have a 1 in 185 risk. Gliomas (of which there are four subtypes) are said to account for about half of all brain tumours. Therefore, a 40% increase in risk would be on the top of a relatively low baseline risk that any person has of developing a brain tumour.

So do mobile phones definitely cause cancer?

No. The IARC’s classification means there is some evidence linking mobile phones to some types of brain cancer but that this evidence is too weak to draw strong conclusions.

Experts point out that there have been a relatively small number of studies on mobile phones and cancer. Most of these are case-control studies. They compare people who already have cancer (cases) with healthy people (controls), and ask them about how they used their phones in the past.

So far, only one study (in around 420,000 Danish people) has actually used the preferable method of following a group of healthy people in the long term to see if their use of mobile phones affected their future risk of cancer. This study found no evidence for an association between tumour risk and mobile phone use among either short-term or long-term users.

Cancer Research UK said that while a small number of studies had found associations between mobile phones and brain cancer risk, most had found no evidence of a link between brain cancer (or any other type of cancer) and mobile phone use for at least 10 years.

In many of the studies results do not reach statistical significance. For example, only one study out of 14 looking at short-term use found that mobile phones significantly affect the risk of cancer. Pooled estimates, representing the combined results from numerous studies, suggested that mobile phones do not affect the risk of cancer.

Cancer Research also said that the studies conducted so far had several weaknesses that undermine their reliability. For example, mobile phone technology has changed considerably over the past few decades, and it is not clear if studies based on use of old models will also apply to new ones.

It's also difficult to assess someone's exposure to mobile phone radiation, and studies often rely on questionnaires asking participants to accurately remembering their mobile phone use over years or decades, which could undermine reliability.

Also, if mobile phones increase the risk of brain cancer, the rates of this disease should theoretically be skyrocketing since mobile phone use has risen dramatically over the last few decades, but studies have found no such trends. However, brain cancers can take many years to develop so it is possible that trends would only start rising after more time.

How might mobile phones cause cancer in the body?

So far experts are uncertain about the biological mechanisms by which mobile phones might increase the risk of cancer. Cancer Research UK point out that phones give off microwave radiation, but that the levels involved are millions of times less energy than, say, an X-ray, and are not thought powerful enough to damage our DNA.

How can I reduce my exposure to mobile phone radiation?

The WHO has advised that until further research is undertaken, people should try to reduce their mobile phone exposure by using hands-free devices or by texting instead.

The Department of Health says that although there is no immediate concern, current advice is that children and young people under 16 should be encouraged to use mobile phones for essential purposes only and to keep calls short. The body and nervous system is still developing in the teenage years and limiting mobile phone use is a precaution, it says.

For specific ways to reduce exposure see Health A-Z: advice on mobile phones.

Australian Government
Australian Radiation Protection and Nuclear Safety Agency

Statement on IARC announcement on classification of radiofrequency

3 June 2011

The radiofrequency electromagnetic fields emitted by mobile phones and other communication devices may be carcinogenic to humans, the International Agency for Research on Cancer (IARC) announced on 31st May following an 8-day meeting to assess the scientific evidence.

After reviewing the large body of peer-reviewed scientific research on the subject, the 31 member working group, made up of expert scientists from 14 countries, classified radiofrequency electromagnetic fields as a Group 2B carcinogen – "possibly carcinogenic to humans".

IARC's classification was based primarily on epidemiological studies of glioma, a malignant type of brain cancer, which some studies have shown to occur more frequently in heavy users of mobile phones. These studies could not rule out other possibilities for the apparent increase in risk but indicated that radiofrequency electromagnetic fields were credible as a cause.

ARPANSA welcomes the report and considers that the classification by IARC corresponds to the current ARPANSA advice, including its advice on practical ways in which people can reduce their exposure to the electromagnetic fields produced by wireless telephones. These include : limiting call time, preferring use of land-line phones, using hands-free or speaker options and texting instead of making voice calls. Use of the phone in good signal areas will also usually let the phone communicate with lower power levels and further reduce exposures. ARPANSA has also recommended parents encourage their children to use these methods of reducing exposure.

ARPANSA does not consider that the new classification should give rise to any alarm.

IARC, a World Health Organization (WHO) agency, classifies chemicals, biological agents, physical agents and lifestyle and work practices according to the evidence that they cause or accelerate cancer. When the evidence is strong the classification is Group 1 – Carcinogenic to humans. When the evidence is less convincing the classification is Group 2A – Probably carcinogenic to humans. When the evidence is limited but a role in causing cancer still possible, the 2B classification – possibly carcinogenic to humans - is given as in the case of radiofrequency electromagnetic fields.

IARC's assessment does not discuss what level of risk might be associated with a particular level of exposure. The WHO will commence an overall health risk assessment for radiofrequency electromagnetic fields taking into account the IARC classification.

Exposures to the radiofrequency electromagnetic fields from mobile phones and base stations are regulated by the Australian Communications and Media Authority to levels set by ARPANSA in its *Radiation Protection Standard for Maximum Exposure Levels to Radiofrequency Fields - 3 kHz to 300 GHz* (2002) (link: http://www.arpansa.gov.au/Publications/codes/rps3.cfm). This Standard includes a precautionary requirement to minimise unnecessary public exposure to radiofrequency electromagnetic radiation. Typical exposures to the public from mobile phone base stations are well below international and Australian exposure limits and very far below the localised exposures from mobile phone handsets.

ARPANSA will consider the implications of the IARC decision and the underlying scientific evidence and, if necessary, review the current standard and other means of protecting the public.

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The press statement from IARC is available at:

http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf

and an audio file of the media briefing at:

http://terrance.who.int/mediacentre/audio/press_briefings/

Other commentary on the IARC classification is available from:

- Cancer Council Australia:
  http://www.cancer.org.au/Newsmedia/mediareleases/mediareleases2011/1June2011.htm

- Health Protection Agency, UK:
  http://www.hpa.org.uk/NewsCentre/NationalPressReleases/2011PressReleases/110531electomagneticfields/

- American Cancer Society:
  http://www.cancer.org/Cancer/news/News/who-says-cell-phones-possibly-cause-cancer

Media Release
1 June 2011

World cancer research agency finds possible link between mobile phones and cancer

Australians should not be alarmed about findings released today (1 June) from an expert group classifying mobile phones as "possibly carcinogenic to humans", according to Cancer Council Australia.

Cancer Council Scientific Advisor and international carcinogens expert, Professor Bernard Stewart, said the findings released by the International Agency for Research on Cancer (IARC), found a "possible link" between mobile phones and cancer, but not a proven one.

The announcement follows an eight day meeting of 31 scientists from 14 countries, who reviewed the results of hundreds of studies covering exposure to radio frequency electromagnetic fields.

"These findings show limited evidence linking mobile phones to glioma and acoustic neuroma and inadequate evidence to draw conclusions for any other types of cancer," Professor Stewart said. "However, it does sound a warning bell and highlights the need more research in this area."

According to Australian Institute of Health and Welfare data, brain cancer incidence has remained steady over a 25 year period to 2007, between 6.3 and 7.3 cases per 100,000 Australians.

Chair of Cancer Council Australia's Occupation and Environmental Cancer Committee, Terry Slevin, said while IARC's classification was possible rather than proven risk, it would be prudent for mobile phone users, particularly heavy users, to take measures to minimise any potential risk.

"There are practical measures people can take such as using hands free devices and more texting as an option to voice calls," he said. "We would also urge greater caution for children using mobile phones as their brain tissue is still developing.

"However, these findings need to be put in context. While we need to continue researching the possible link between mobile phones and cancer, it is important to remind people there are many more established cancer risk factors that we can take action every day. Strong action on clear cancer risks like tobacco, alcohol, excessive UV exposure and obesity remain a priority."

IARC's findings follow results released last year from the largest international study to date into mobile phone use, which has found no evidence that normal use of mobile phones, for a period up to 12 years, can cause brain cancer.

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http://www.thecourier.co.uk/Community/Health/article/14539/cancer-expert-plays-down-mobile-phone-link-with-brain-tumours.html

Cancer expert plays down mobile phone link with brain tumours

A cancer expert from a Fife charity has played down claims that using a mobile phone may increase the risk of brain tumours.

- Published in the Courier : 02.06.11
- Published online : 02.06.11 @ 02.33pm

Scientists from the World Health Organisation's International Agency for Research on Cancer (IARC) said use of devices should be classified as "possibly carcinogenic" following a review of evidence.

But Dr Mark Matfield, scientific co-ordinator of the Association for International Cancer Research (AICR), which has its headquarters in St Andrews, said there was no good evidence linking the technology with the disease.

The new classification puts mobile phone use in the same risk category as lead, choloroform and coffee.

Some evidence, the WHO agency said, suggested a link with an increased risk with the brain cancer glioma.

Director Christopher Wild said research was needed into long-term and heavy use of phones and pragmatic measures were needed to reduce exposure until such information was available, such as use of hands-free devices and texting as an alternative.

Dr Matfield advised people against being misled by some of the tabloid headlines.

He said, "The WHO/IARC have put mobile phones in the lowest possible category — possible but not likely — to increase the risk of brain cancer.

"Let's put that in perspective.

"It is possible I will win the lottery this weekend, but it's not very likely.

'No convincing evidence'

He added, "I think the WHO/IARC are being very cautious by doing this.

"If you look at the evidence from all the research into this, the majority of the studies — including all the larger and the best-designed studies — found no increase in cancer among mobile phone users.

"On the balance of evidence, you would have to say they are not a cancer risk."

Dr Matfield said, "There is no convincing evidence linking mobile phone use and cancer.

"There is not even any good evidence, there is some debatable evidence."

He added, "I think that is why IARC/WHO have done this — they don't want the debate closed, they want more research to be done."

"Indeed more research is currently under way."

The AICR funds research around the world into the causes of cancer.

Pictured used under Creative Commons licence courtesy of Flickr user Ed Yourdon.

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People: Mark Matfield, Christopher Wild | Organisations: WHO, IARC, AICR, International Agency for Research on Cancer, World Health Organisation, Association for International Cancer Research | Places: St Andrews, Fife | Concepts: Coffee, Lead, Tumours, Cancer, Mobile phones, Chloroform, Carcinogen, Glioma

http://www.cancer.ie/news/news.php?newsID=464?h

Irish Cancer Society News

Date: 01 Jun 2011

Irish Cancer Society Statement on International Agency for Research on Cancer (IARC)/ World Health Organisation (WHO) study on radiofrequency electromagnetic fields and cancer

Yesterday, the International Agency for Research on Cancer (IARC), part of the World Health Organisation (WHO), classified radiofrequency electromagnetic fields, emitted by mobile phones, as Group 2B* carcinogenic. This means that there is potential for harm from mobile phones but there is insufficient evidence to say there is a direct effect.

IARC drew these conclusions having invited over 30 experts to review all the data so far on mobile phone usage in a number of research studies. IARC states that evidence of a possible association between mobile phone usage and cancer is limited and is linked to two types of brain cancers, glioma and acoustic neuroma, but is inadequate to draw conclusions for other cancers.

The Irish Cancer Society agrees with IARC's recommendations that further research on the impact of mobile phone usage needs to be carried out - however people should be aware of the possible risk of mobile phone usage. The Irish Cancer Society also agrees with their recommendation that until more conclusive information becomes available people are advised to limit exposure to the potential harm by using hands-free devices or texting.

***Group 2B carcinogen**

Group 2B means that there is some evidence for a risk but it's not that conclusive. A Group 2B carcinogen is classified as possibly carcinogenic to humans. It means there is limited evidence that something causes cancer in people, and even the evidence from animal studies is less than sufficient for a conclusive position.

irish cancer society
the national charity for cancer care

http://www.canada.com/health/Call+concern+cellphone+emissions+carcinogenic+says/4868280/story.html#ixzz1NyKX64T5

Call for concern: cellphone emissions may be carcinogenic, says WHO

By Sarah Schmidt and Carmen Chai, Postmedia News June 1, 2011


Photograph by: Spencer Platt, Getty Images

A man speaks on his mobile phone on May 31, 2011 in New York City. In a new report by 31 scientists meeting at the World Health Organization's International Agency for Research on Cancer (WHO/IARC) it was found that using a mobile phone may increase your risk for certain kinds of brain cancers. While further scientific work will be conducted, the group of scientists from 14 countries classified cellphones in the carcinogenic category 2B, which is similar to the pesticide DDT and gasoline engine exhaust.

Radiation emitted from cellphones may be carcinogenic and consumers should change their habits to reduce exposure just in case, the World Health Organization's cancer research institute said Tuesday in a move that could see national governments review their mobile phone regulations designed to protect public health.

The International Agency for Research on Cancer (IARC) said there is now enough evidence for the new classification of radio-frequency electromagnetic fields as "possibly carcinogenic" to humans, based on an increased risk of glioma, a malignant type of brain cancer, associated with wireless phone use.

With estimates of five billion cellphone users worldwide, a working group of 31 scientists, including two Canadians, assessed the evidence of the potential link between health and cellphone use at a weeklong session in Lyon, France, to find that exposure to electromagnetic fields, such as those emitted by wireless communication, could be harmful.

"The bottom line, after reviewing essentially all the evidence that is relevant to looking at radio-frequency electronic magnetic fields, the Working Group classified radio-frequency electronic magnetic fields as possibly carcinogenic to humans," Dr. Jonathan Samet, a University of Southern California professor who was chairman of IARC's working group, told reporters Tuesday.

"The conclusion means that there could be some risk, and therefore we need to keep a close watch for a link between cellphones and cancer risk," Samet said in a statement.

This category, also known as a Group 2B, is used when there is limited evidence of carcinogenicity in humans and less than sufficient evidence in experimental animals. Other

categories include "carcinogenic (Group 1), "probably carcinogenic" (Group 2A), "not classified as to its carcinogenicity" (Group 3) or "not carcinogenic" (Group 4).

In an interview, James McNamee, a research scientist at Health Canada's electromagnetics division and member of IARC's working group, said it's vital to put the new classification in perspective.

"The best way to define this is it's a recognition that there is some evidence from human studies and from animal studies. It's very important to state that this evidence is far from established and it's far from causal, but it is a recognition that a lot of work has been done, a great deal of work has been reviewed and it's a statement of where the science is in time," said McNamee.

IARC's decision, supported by a vast majority of members of the working group, did not quantitate the risk, but flagged results of an IARC study showing a 40 per cent increased risk for gliomas in the highest category of cellphone users. This was calculated as a reported average use of 30 minutes per day over a 10-year period.

The new classification, which will be published in the IARC monograph, is sure to set off further debate about a pressing public-health issue facing consumers as mobile phone use continues to climb.

For the working group, it demands further research.

"Of course, as use patterns continue to grow, we can anticipate an ever larger population that is exposed for longer and longer. With this classification comes the need for ongoing research and tracking," said Samet.

More definitive findings may take a while, but Samet added that consumers should stay tuned — because he expects the group to publish an updated monograph at some point, after additional evidence is published to deal with "acknowledged gaps and uncertainties" in the current research, said Samet.

"This volume represents an important first look by IARC at an exposure that is increasingly prominent, one that is really transforming the world. I think I can probably say one thing with certainty — there will probably be another monograph. What number it will be, I don't know, but I think that will depend on the pace at which the scientific community continues to develop evidence about this very important form of exposure in our society."

Pending the availability of additional information, IARC director Christopher Wild said "it is important to take pragmatic measures to reduce exposure," such as hands-free devices or texting.

In an interview, working group member and University of Montreal epidemiologist Jack Siemiatycki said such steps would be reasonable, depending on personal levels of concern of a possible hazard.

"We make decisions constantly about risks. For the time being, for the individual users, anyone who is concerned about this — and it's not unreasonable to be concerned about this — can have options for reducing their exposure to radio-frequency fields from mobile phones," added Siemiatycki.

Regulators such as Health Canada also should take note of the classification, even though it's a "first-level concern" or "probably the lowest level of flag that IARC uses for raising concern about possible carcinogens," said Siemiatycki.

"It puts the question of radio-frequency fields and cancer somewhat more officially on the agenda of the scientific community, of public health agencies and governments and industry. . . . It calls for concern, it calls for attention to be given to the problem."

In a statement, the Canadian Wireless Telecommunications Association, played down concerns but said the new monograph will now be considered by health authorities "in order to evaluate if there are any overall impacts on our health from mobile phones and their base stations and what needs to be done in order to address them."

In the meantime, "it is important to note that IARC has only assessed the potential that RF electromagnetic fields are a possible health hazard in some circumstances, and not the likelihood that in normal use they do cause risk. The Group 2B classification — 'the agent is possibly carcinogenic to humans' — is used for agents for which there is some suggestive evidence, but there is limited, insufficient and/or inadequate evidence of carcinogenicity."

Since 1971, IARC has evaluated more than 900 agents, and identified 400 as carcinogenic or potentially carcinogenic to humans.

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Mobile Phones, Brain Tumours and the Interphone Study: Where Are We Now?

Anthony J. Swerdlow, Maria Feychting, Adele C Green, Leeka Kheifets, David A Savitz

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NIEHS
National Institute of Environmental Health Sciences

National Institutes of Health
U.S. Department of Health and Human Services

Mobile Phones, Brain Tumours and the Interphone Study:

Where Are We Now?

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Running title: Mobile Phones and Brain Tumour Risk

Key words: Brain cancer, cancer and radiation, epidemiology.

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Conflict of Interest Statement

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Abbreviations: CI = confidence interval; OR = odds ratio; RF = radiofrequency; SAR = specific (energy) absorption rate

Abstract

Background

In the past 15 years, mobile phone use has evolved from an uncommon activity to one with over 4.6 billion subscriptions worldwide. There is, however, public concern about the possibility that mobile phones might cause cancer, especially brain tumours.

Objectives

To review the evidence on whether mobile phone use raises risk of the main types of brain tumour, glioma and meningioma, with a particular focus on the recent publication of the largest epidemiological study yet – the 13-country Interphone Study.

Discussion

Methodological deficits limit the conclusions that can be drawn from Interphone, but its results, along with those from other epidemiological, biological and animal studies, and brain tumour incidence trends, suggest that within about 10-15 years after first use of mobile phones there is unlikely to be a material increase in the risk of brain tumours in adults. Data for childhood tumours and for periods beyond 15 years are currently lacking.

Conclusions

Although there remains some uncertainty, the trend in the accumulating evidence is increasingly against the hypothesis that mobile phone use can cause brain tumours in adults.

Introduction

In just 15 years the mobile phone has evolved from an uncommon, expensive, brick-shaped object used in restricted areas of Western countries to a convenient and ubiquitous part of modern life, with more than 4.6 billion subscriptions worldwide (International Telecommunication Union 2010). The arrival of this mass technology has been accompanied by some public and media concern about the possibility that the radiofrequency (RF) fields emitted by the phones might cause cancer, especially brain tumours. Numerous committees have considered the evidence and recommended more research (IEGMP 2000; SCENIHR 2009). Since 1999, a series of epidemiological studies of mobile phone use and cancer have been published, mainly focused on brain tumour risks. Collectively, they have not provided evidence of a relationship, but they have had sufficient limitations to leave the question unresolved (Ahlbom et al. 2009).

The Interphone study was launched in 2000, to provide a more powerful and methodologically rigorous investigation of this issue by collecting data in 13 countries. Now, 10 years and €19M later, after much anticipation and a lengthy delay, the key results on brain tumours have been published (INTERPHONE Study Group 2010). What should be made of them, considered along with the rest of the literature? Do we now know whether mobile phones cause brain tumours? Or if not, how much closer are we to knowing?

The Interphone Study

The Interphone study was an international, coordinated interview case-control study, investigating the potential effect of mobile phone use on the risk of the two commonest types of brain tumour, glioma and meningioma (and, although not yet published, also acoustic neuromas and parotid gland tumours). It used a common core questionnaire and to some extent a common core protocol, but deviations and additions were allowed: for instance, cases were population-based in most countries but hospital-based in Japan and France, and controls were pair matched at 9 centres but stratum matched in the other 7. These methodological inconsistencies add to the difficulty of interpreting the overall results. Nevertheless, the multicentre structure enabled a study of exceptional size: more than 5,000 patients with these relatively uncommon tumours were interviewed in a five year period – a considerable feat.

The study questionnaire asked in detail about the type and pattern of use of each mobile phone the respondent had used, and about other RF exposures and brain tumour risk factors. The questionnaire was administered by an interviewer using a computerised laptop data entry system (except in Finland), with practical advantages but with the disadvantage that there were no original paper records available to check the fidelity of data entry for apparently erroneous values. The questionnaire collected information on hands-free phone use, which was excluded from analyses since head exposure is then negligible. It is unknown, however, how well subjects can recall past use of hands-free devices, and whether recall differed between cases and controls.

The analyses employed post hoc matching of one control per case (two for Germany) for the centres that had used a stratified control selection. Individually matched analyses were then used for the analyses. This resulted in loss of data: 70 cases and over 2000 interviewed controls were not included in the final analyses. Furthermore, most of the national studies that contributed to Interphone covered a wider age-range (as low as 18 and/or up to 69) than the Interphone analyses (30-59), so that a considerable proportion of the national data (e.g., 58% for Sweden (Lonn et al. 2005)), were not included in the overall pooled analyses. The national publications need to be considered, therefore, as additional semi-independent sources of evidence, not simply as subsets of the overall Interphone analysis.

The Interphone publication (INTERPHONE Study Group 2010) compared 2708 glioma cases diagnosed at ages 30-59 years during 2000-2004, with 2972 controls, and 2409 meningioma cases with 2662 controls. Participation rates were 64% for glioma cases, 78% for meningioma cases, and 53% for controls, with considerable variation among study centres; proxies were used for 13% of glioma cases, 2% of meningioma cases and 1% of controls. Sensitivity analyses did not suggest, however, that the results were dependent on participation rates across centres or on inclusion of proxies.

Key findings were a significantly diminished risk of both glioma and meningioma in regular users compared with people who were not users or were occasional users ("non-users"); no trend in risk of either tumour type with cumulative hours of use but an apparent raised risk of glioma, and to a lesser extent meningioma, in those in the top decile of cumulative hours of use; and no relation of risk of either tumour type to

cumulative number of calls, years of use or years since first use. These results raise several important issues:-

Reduced Risk of Brain Tumours in Mobile Phone Users

The Interphone Study, as well as some previous case-control studies (Inskip et al. 2001; Muscat et al. 2000) and the only large cohort study (Schuz et al. 2006), identified a reduced risk of brain tumours among mobile phone users compared with non-users. In the Interphone study as a whole, ever-regular use was associated with an odds ratio of 0.79 (0.68-0.91) for meningioma, and 0.81 (0.70-0.94) for glioma. The pattern was consistent across the Interphone study sites and statistically precise, calling for explanation.

There is empirical evidence that the reduced risks were in part due to non-response bias (Vrijheid et al. 2009). Cases and controls who initially declined to participate but agreed to complete a short non-response questionnaire had lower frequencies of regular mobile phone use than those who participated fully. The quantitative results from this non-response questionnaire imply that selection bias would produce an odds ratio of 0.87-0.92 if the null hypothesis were true. It seems unlikely that differential response based on mobile phone use could explain the diminished risk entirely since the reduction in risk was similar for study centres that did and did not reveal to potential participants the study's focus on mobile phone use.

Even if the same pattern of diminished response by non-users occurred for cases and controls, which it did not, the overall greater non-participation among controls due to

refusal would result in a downward bias in the odds ratio. Whereas only 11% of glioma and meningioma cases refused to participate, 30% of controls did so. Furthermore, the phone use of those who did not complete even the non-response questionnaire (e.g. because of refusal or death) is unknown, adding further uncertainty to the extent of the overall bias.

Other likely contributors to the diminished ORs in users are prodromal symptoms such as headaches and impaired cognition, which may have prevented recent initiation of mobile phone use among subjects with as yet undiagnosed brain tumours. Thus some cases who would otherwise have become short term users may have remained non-users, leading to artefactually reduced odds ratios for brain tumour in phone users, especially short term users (and low cumulative users, since short term use will tend to result in low cumulative use). It seems likely that this accounts for at least part of the decreased risk in users because the strongest reduction in glioma risk was found in the shortest term users. Other potential contributors to diminished ORs can be hypothesised, but there is no evidence for them (see Supplemental Material, page 1).

The appropriate analytic approach and interpretation in the light of this presumably non-causal reduction in risk is not obvious. One suggested response has been to alter the referent group, by using low regular use rather than non-use plus occasional use as the referent. This results in an upward shift in the odds ratios across the board, more for glioma than meningioma, but no change in the magnitude of those odds ratios relative to one another across the range of exposure (INTERPHONE Study Group 2010). However, whether this decreases or increases the bias is dependent on two

factors –whether the diminished risk is due to non-response, and whether the biases apply also to low level users as well as non-users. Neither of these factors is known, but to the extent that the diminished risk is due to prodromal symptoms, changing the referent group would produce upward bias. If short term users (or low cumulative users) are used as the referent exposure group, the more pronounced risk reduction in this group caused by prodromal symptoms would make relative risks for long term users (or high cumulative users) biased upward.

Risks after prolonged and heavy mobile phone use

If exposure to RF fields through mobile phone use were tumourigenic, people using mobile phones longest and those who were the heaviest users would be expected to show the highest risks of brain tumours. Reliability of recall of amount of use a decade ago is unknown, and the average amount of use is likely to have shifted over time as phone use has escalated universally. Validation studies of recall of phone use in the last six months, and up to approximately 5 years in the past, have found that even in the short term, subjects on average underestimate the number of calls per month but overestimate duration of calls, with moderate systematic error (underestimation by light users, overestimation by heavy users) and a large amount of random error (Vrijheid et al. 2006). Recall of number of calls was found to be better than recall of their duration. Furthermore cases in Interphone more often than controls gave implausibly high estimates of overall time spent on calls (e.g., 10 cases and no controls reported average use of >12 hours/day). A validation study including both cases and controls found that there was overestimation by cases in more distant time periods that could cause positive bias in risk estimates (Vrijheid et al. 2009). It thus

appears that recall of amount of use was appreciably erroneous and quite likely different for cases than controls. It is possible that recall of year of first use, and hence duration of use, may have been more reliable than recall of amount of use.

Notwithstanding the inherent unreliability of recalled amount of use, the only cumulative mobile phone exposure measures available in Interphone were duration and amount. Neither yielded material evidence of a positive association with brain tumours. Specifically, for the longest-term users (10+years since first use), no association was seen for glioma (OR 0.98 (95% CI 0.76–1.26)), or meningioma (OR 0.83 (95% CI 0.61–1.14)). Most ORs were <1.0 and no dose-response pattern was seen. This is consistent with results from a cohort study based on subscriber lists (Schuz et al. 2006) but in contrast with the raised risks for long-term use reported by Hardell et al (Hardell et al. 2006a; Hardell et al 2006b). For heavy use measured by estimated total number of calls, again there was no positive association with brain tumours: ORs were <1.0 in all categories of numbers of calls, including those in the top decile, for both glioma and meningioma. For heavy use assessed by cumulative duration of calls, again there was no dose-response effect for either type of tumour. For glioma, while the risk estimate for subjects in the highest decile of total call-time ($\geq$1640 hours) was modestly raised at OR 1.40 (95% CI 1.03– 1.89), it was disjointed from the risk in the next heaviest users, the second highest decile, which was one of the lowest risk estimates: OR 0.71 (95% CI 0.53-0.96). Similarly for meningioma the OR in the highest decile of total call-time OR was 1.15 (95% CI 0.81– 1.62), while in the next heaviest decile of users it was 0.76 (95% CI 0.54-1.08). Furthermore, the top 'decile' category presented was not actually 10% of the control data – it is unknown to what extent risk would have been raised in the true top decile, or to what extent the

raised risk is a function of the cut-point chosen (about the 7th centile for menigioma, and the 8th centile for glioma).

The only previously available risk estimates among comparably heavy users are from case-control studies conducted by Hardell et al (2006a, 2006b) in Sweden, who reported a markedly raised risk and positive dose-response gradient for "malignant tumours" but not for meningioma. We have discussed elsewhere why the Hardell results are problematic (Ahlbom et al. 2009). Assessment of the findings with respect to cumulative call time in individual published component studies of Interphone, whose participants variously covered a wider range of ages than Interphone, confirmed the lack of dose-response effect with glioma (see Supplemental Material, page 2). Furthermore, for number of calls, which validation studies suggest may be better-reported than cumulative hours of exposure, there was no indication of raised risk in the top decile or of dose-response.

Finally, participants who had been using mobile phones the longest (>10 years) and had accumulated highest lifetime call hours (≥1640 hours) might be expected *a priori* to have been at the highest risk if RF exposure were tumourigenic. This was not the case however for either glioma (OR 1.34 (95% CI 0.90-2.01)) or meningioma (OR 0.95 (95% CI 0.56-1.63)) (INTERPHONE Study Group, 2010). Instead it appeared that the very few individuals who started regular use only 1-4 years ago, yet whose cumulative call time fell in the highest decile, due to their reported recent heavy use, carried the greatest risk of both tumour types: for glioma OR 3.77 (1.25-11.4) and for meningioma OR 4.80 (1.49-15.4), with no dose-response. The similarity of the results for meningioma and glioma suggests that shared recall bias exists, since such a short-

term usage period should have little or no bearing on the pathogenesis of meningioma, which tends to have a long latent period.

The magnitudes of relative risk of glioma and meningioma found in the top decile of cumulative use of phones were not large (1.40 and 1.15, respectively), and are on the margins of what epidemiology can detect. It is at a level at which the errors and biases identified in the study data provide a plausible, indeed at present a more plausible, alternative explanation of the findings than does causation. Furthermore the analyses were derived from a very large number of comparisons investigated (some reported in the paper, the great majority not), and hence there was the potential for selective emphasis in presentation of the results.

In summary, Interphone and the literature overall have methodological deficiencies but do not demonstrate greater risk of either glioma or meningioma with longer or greater use of mobile phones, although the longest period since first use examined is <15 years.

Anatomical distribution of the tumours compared with anatomical distribution of exposure

RF exposure during mobile phone use is highly attenuated within a few centimetres in the brain, and therefore exposure is largely to the side of the brain, and to the anatomical area, closest to the antenna. It has been reported that on the side of the brain where the phone is used, 50-60% of the total RF energy is absorbed in the temporal lobe and the average specific absorption rate (SAR) is highest in the

temporal lobe and the cerebellum (Cardis et al. 2008). Thus examination of location of the tumour in relation to location of exposure is of interest.

Laterality

If there were a causal association between mobile phone use and brain tumour risk, one would expect an increased risk on the same side of the head as the phone is held, and a null finding on the opposite side. On the other hand, if some brain tumour patients believed that mobile phone use had caused their tumour, and consequently over-reported use on the affected side, this would result in an apparent risk increase on the same side of the head accompanied by a decreased risk on the opposite side. (The same bias is not possible for controls, who do not have a tumour side). Furthermore, if there were a causal relationship, one would expect an effect of laterality to occur after a sufficient induction period, not for solely recent use (unless there were a very rapid and substantial promotional effect of mobile phones, which presumably would be detectable easily and rapidly from population incidence trends).

ORs for glioma and meningioma in the Interphone study tended to be greater in subjects who reported usual phone use on the same side of the head as their tumour than on the opposite side for most categories of duration of use, cumulative call time and cumulative number of calls. Most ipsilateral ORs were not above unity, however, and there was no dose-response trend, although the greatest ORs tended to be for the top decile of ipsilateral exposure.

There are currently no validation studies of retrospective self-reported side of use, and there is no evidence of consistency over time in the preferred side of use. Overall, the greater risk for reported ipsilateral than contralateral use would be compatible with causation or bias as an explanation, but the finding that contralateral risks and many of the ipsilateral risks were generally below unity, with no consistent pattern of greater ipsilateral/contralateral ratios with greater exposure (except for cumulative number of calls and risk of glioma), would favour bias as the explanation.

Lobe

The risk of glioma in the temporal lobe for regular use and for most categories of exposure was reduced and not different from that in other lobes. ORs for long term use and highest cumulative call time, however, were somewhat greater in the temporal lobe than in other lobes: this is the pattern one would expect if there were a causal effect, although there was no suggestion of a dose-response effect for temporal tumours, which would also be expected if there were causality. No coherent pattern was observed for meningioma, for which the OR for temporal lobe tumours for regular use was somewhat lower than for other lobes and there was no evidence of greater risk in the temporal than other lobes in other categories of use.

Exact anatomical location of the tumour

Interphone collected neuroradiological information on the exact locations of brain tumours in the study. Although this has not been published for the study overall, it has been published for glioma for many of the study centres and meningioma for one

centre. These analyses gave no indication of an association of tumour risk to proximity of the tumour to the exposure source (Larjavaara et al., 2011; Takebayashi et al. 2008).

In summary, among the three types of data on anatomical location, the results for laterality of phone use are the least interpretable. They are compatible with bias, or at least partly with causation, but do not give firm evidence for either. The evidence on lobe of glioma, but not of meningioma, is inconsistently in the direction that would be expected with causality, but not decisively so. The evidence on exact location of the tumour, which one would expect to give the most rigorous analysis since it has greater precision without bias, does not support a causal association.
Data on tumour risk in relation to type of mobile phone, and hence of exposure, have not suggested a relation (Supplemental Material, page 2).

Other relevant evidence

The biological literature on RF and cancer does not support an aetiological effect - extensive research has not established any biological mechanism by which radiofrequency fields, which are not mutagenic, could cause cancer, and animal experiments have given no replicable evidence for cancer causation in animals (SCENIHR 2009).

The major biases and uncertainties in interpretation of the Interphone study are similar to those in other interview-based case-control studies of brain tumours and mobile phones. The exceptional size of the Interphone study has not proved to be a critical

strength – issues of bias and misclassification have proved far more important than tightness of confidence intervals. Therefore, more studies of the same basic design as Interphone, based on recall of phone use, no matter how carefully designed and conducted are unlikely to add materially to our knowledge. There are other epidemiological designs that do not share these weaknesses (although they have others), whose results need consideration in relation to the uncertainties remaining after Interphone: studies of the effects of occupational and residential RF exposures; record linkage-based case-control and cohort studies of phone use; and trend analyses of brain tumour incidence rates in the general population.

The occupational studies, and those of cancer risk in relation to residential proximity to RF broadcasting towers, have not indicated any cancer risk although they have been methodologically weak (Ahlbom et al., 2004). Studies that have linked private non-corporate telephone subscription records to cancer registry records (in certain Nordic countries) (Auvinen et al., 2002; Schuz et al., 2006) or death records (in the US) (Dreyer et al., 1999) have the strengths that they avoid recall bias and misclassification, and avoid participation bias. They have the weaknesses, however, not present in interview case-control studies such as Interphone, that the subscription data exclude corporate subscriptions, which in the early years were likely often to have been held by heavy users, and that the named subscriber is not necessarily the user. These problems are likely to have diluted any true association. A US cohort study (Dreyer et al.1999) was halted one year after recruitment, so was essentially uninformative. A national records-based case-control study in Finland (Auvinen et al. 2002) based on very short durations of use found a borderline significantly raised risk of glioma in ever-users with some evidence for a relation to analogue not digital

phone use. A Danish cohort study (Schuz et al. 2006) followed 420,000 phone subscribers over a period of 7-21 years and gave no indicationof raised risk of glioma or meningioma nor any trend in risk with duration since first use.

Analyses of secular trends in brain tumour incidence, in countries that have had good quality diagnostic facilities and cancer registration, can give powerful evidence constraining what can reasonably be proposed as an aetiological relationship. The dramatic rise in mobile phone use over a relatively short period of time provides an unusual opportunity to assess the potential for a causal effect on cancer occurrence through high quality, unbiased descriptive epidemiological data. As substantial misclassification is inevitable in recall-based exposure information from the Interphone interviews, it follows that if the raised relative risk observed in the top decile of users in the Interphone study were causally due to phone use, not chance or artefact, then the true effect would likely be much larger, and therefore more easily detectable in population cancer incidence trends. However, data from the Nordic countries 1974-2003 (Deltour et al, 2009), children in the Nordic Countries 1985-2006 (Schmidt et al, 2011), Switzerland 1969-2002 (Roosli et al, 2007), England 1998-2007 (de Vocht et al, 2011) and the US 1992-2006 (Inskip et al, 2010) and 1987-2007 (Kohler et al, 2011) showed no indication of increases in brain tumour incidence in relation to the introduction and growing use of mobile phones, up to 20 years after their introduction and 10 years after their use became widespread.

This does not appear compatible with the greatest risk shown in the Interphone study – the odds ratios of about 4 within 5 years of first use for individuals using a phone for ≥1,640 hours cumulatively, nor with the risk estimates using a 'low user' baseline group, in the Appendix of the Interphone paper.

The Interphone levels of exposure were those in the population in 2003 and earlier, since when prevalence and probably levels of use have increased greatly. Future examination of cancer incidence trend data over the next few years, especially by age of occurrence and anatomical location of tumours, should greatly clarify whether mobile phones cause brain tumours: if there are no apparent effects on trends in the next few years, after almost universal exposure to mobile phones in Western countries, it will become increasingly implausible that there is a material causal effect. Conversely, if there are unexplained rising trends, there will be a case to answer. Supplemental Material Figure 1 shows the most recently available data, up to 2009, from Sweden, one of the earliest adopters of mobile phones; the data give evidence against an impact of mobile phone use on brain tumour occurrence.

Conclusions

Interphone is an impressively large study with multiple indices of exposure. However, it has some methodological deficits, largely inevitable in recall-based case-control studies, which limit interpretation of its findings. Such evidence as it provides, combined with the results of biological and animal studies, other epidemiological studies, and brain tumour incidence trends, suggest that within the first 10-15 years after first mobile phone use there is unlikely to be a material increase in risk of adult

brain tumours resulting from mobile phone use. At present there are no data on risk of childhood tumours.

The deficiencies of exposure measurement, because of recall misclassification in studies such as Interphone, and because of mis-identification of users in records-based studies such as the published cohorts, leave it doubtful that either study type could reliably detect a small effect, if one existed. Both for this reason, and because research cannot in principle prove the complete absence of an effect, but only place limits on its possible magnitude, there is bound to remain some uncertainty for many years to come. The limited duration of data yet available, which is mainly for up to 10 years of exposure and to a lesser extent for a few years beyond this, also leave uncertainty because of the potential for long lag period effects, especially for meningioma which is generally slower growing than glioma. The possibility of a small or a longer term effect thus cannot be ruled out. Nevertheless, while one cannot be certain, the trend in the accumulating evidence is increasingly against the hypothesis that mobile phone use causes brain tumours.

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Supplemental Material

Mobile Phones, Brain Tumours and the Interphone Study:

Where Are We Now?

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Factors potentially contributing to diminished ORs in mobile phone users

As well as non-response bias and prodromal symptoms, reduced ORs in mobile phone users might be due to the following:

Timing of interviews differing between cases and controls combined with strong secular trends in mobile phone use, though this was examined directly in Interphone and found not to contribute; differential misclassification of mobile phone use, but if anything one would expect cases to overreport relative to controls, creating bias toward raised, not diminished, risk for phone users; mobile phone use serving as a marker of socioeconomic or other factors associated with low risk of brain tumour or of its diagnosis. However, the results were adjusted for socioeconomic status, the evidence does not suggest that brain tumours are more common in low social classes, and no other aetiological factor with such an effect is known.

Published results on cumulative call time from Interphone component studies

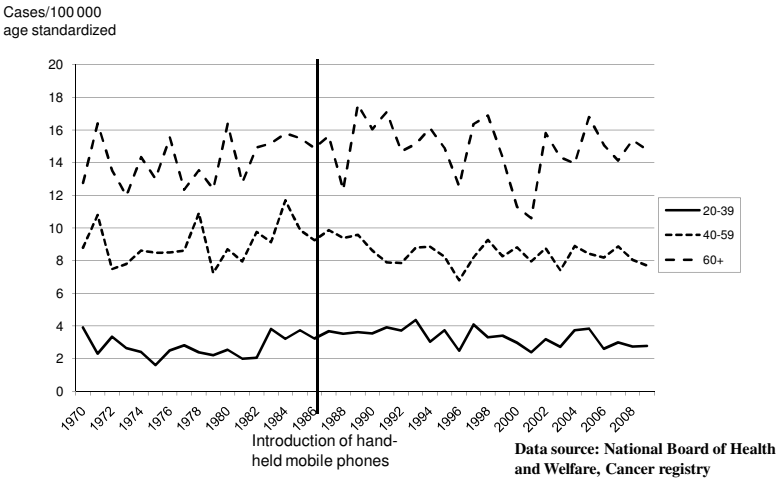
In the seven individual Interphone component studies (Christensen et al. 2005; Hepworth et al. 2006; Hours et al. 2007; Klaeboe et al. 2007; Lonn et al. 2005; Schuz et al. 2006; Takebayashi et al. 2008) and one combined study (Lahkola et al. 2007) published, there were no statistically significant positive associations with cumulative call time observed and no suggestion of any dose-response gradients.

Analogue/digital/cordless phones

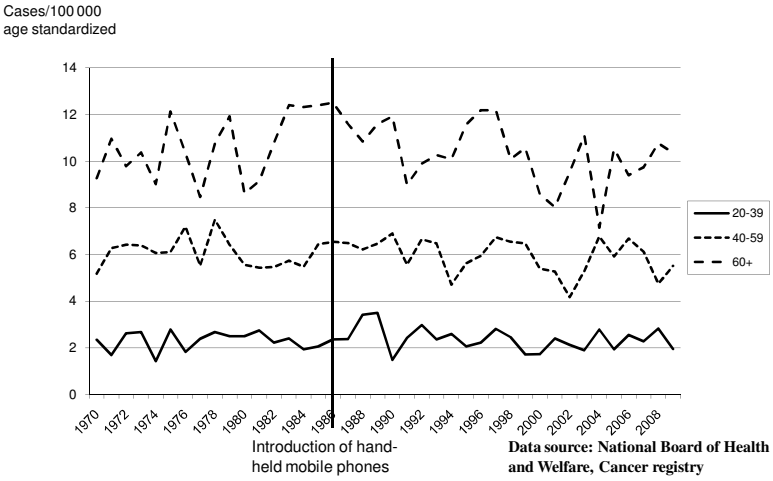
Average output powers from analogue phones have generally been higher than from the digital phones that have replaced them, as analogue phones did not have adaptive power control and because of other technological advances in efficiency. Another difference is that digital phones use pulsed signals. For these reasons, Interphone analysed results for analogue and digital phones separately; however, no consistent differences were found between results for use of these phone types. Similarly, none of the national Interphone publications that published results for analogue and digital phones separately (Hepworth et al. 2006; Klaeboe et al. 2007; Lonn et al. 2005; Takebayashi et al. 2008) indicated any differences in results between analogue and digital phones, despite potential differences in RF exposure from the different phone types. There were greater risks found for analogue than digital use in Hardell et al's data (Hardell et al. 2006a; Hardell et al. 2006b) and, with wide confidence intervals, Auvinen's (Auvinen et al. 2002).

Cordless phones were not included in the analyses of the main Interphone paper, because average output power levels from cordless phones are considerably lower than average output levels from mobile phones. Two of the national Interphone papers did, however, include cordless phone use (Lonn et al. 2005; Schuz et al. 2006), and neither found any indication that such use was related to glioma or meningioma risk. (The results of Hardell et al (2009) were again an outlier, with greatly raised risks). Thus, it seems unlikely that the omission of cordless phone use could have affected the results in the main Interphone paper.

(a) Males

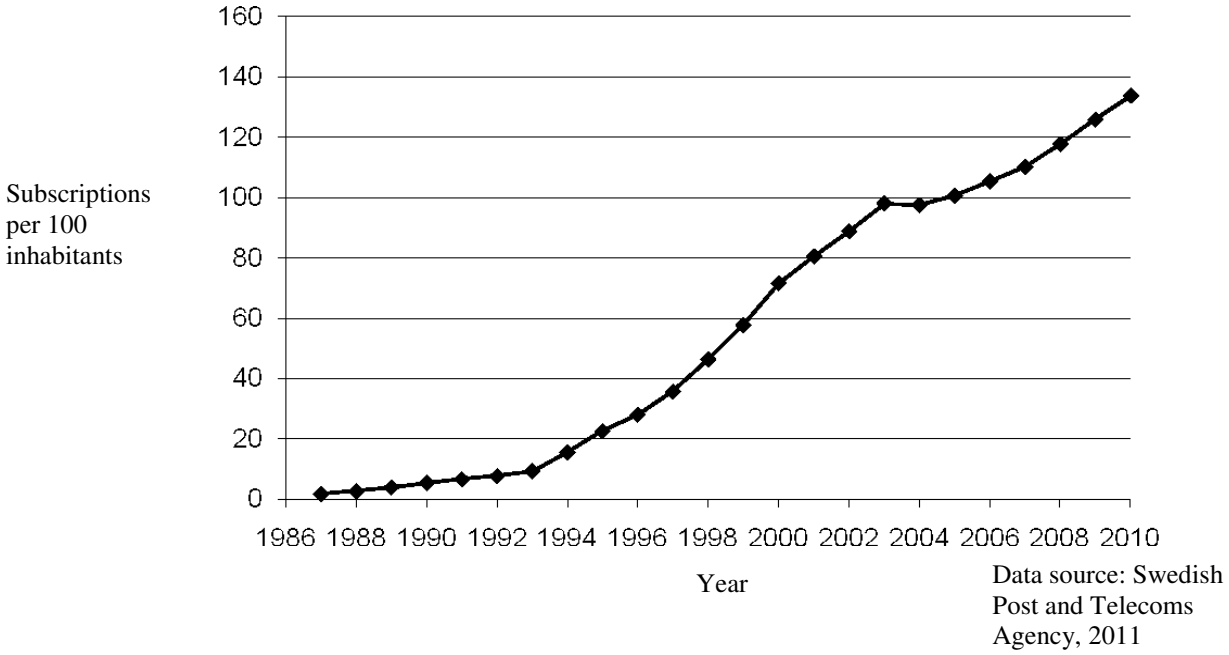


(b) Females



Supplemental Material, Figure 1: Incidence of glioma[a], Sweden 1970-2009, (a) males, (b) females

[a]Based on Swedish cancer registry coding that excludes ependymoma.



Supplemental Material, Figure 2: Mobile phone subscriptions per 100 inhabitants, Sweden, 1987-2010*

*The disjunction in the trend in 2004 is caused by a change in the definition of what constitutes an "active" pay-as-you-go card

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