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The relationship between mobile phone use and risk of brain tumor: a systematic review and meta-analysis of trails in the last decade

Lige Leng

Abstract

The aim of the present meta-analysis was to identify whether there was a relationship between mobile phone use and risk of brain tumor. A comprehensive search strategy was developed, and studies were eliminated in a stepwise manner, based on the inclusion criteria. The current meta-analysis collected data from the 24 eligible studies to investigate the relationship between mobile phone use and risk of brain tumor, while a detailed analysis of different classification was also conducted in order to identify the risk of mobile phone use. From the results, the relationship between cell phone use and brain tumor incidence had no significant difference between men and women. Cell phone use can increase the RF energy absorbed in the brain and apoptosis genes expression level, but glioma cell line cells were not significantly affected. Most calculations of laterality show a trend of increasing risk for time since first use, cumulative duration of subscriptions, cumulative duration of calls, and cumulative number of calls. In Asian people's, cell phone use and glioma had certain relations, while has very little relationship with meningioma incidence. This result seems to be no racial difference. In children and teenagers, cell phone use is associated with the incidence of brain tumors. We need longer time observation to supervise longer time (>20 years) mobile phone use whether has severe effects on incidence of brain tumor.

Keywords: Mobile phone use, Brain tumor, Glioma, Meningioma, Etiology

Background

With the rapid development of communication technology, mobile phones gradually began to rise from the mid - 1990s, and it is now very popular in many countries. Due to the invention of the various APP, people were more and more inseparable from the mobile phones. All aspects of life such as buying goods needed mobile phones to operate. Therefore, whether the using mobile phones harm human health had been received the widespread attention. Mobile phones made people exposed to high-frequency electromagnetic fields. People not only suffered their own mobile phone radiation, but also suffered the radiation due to large number of mobile phones used by other people, which almost made the world now an electromagnetic field. In July 28th 2014, the United States survey organ-Strategy Analytics published, according to a report expected by the end of 2015, that global mobile phone users had been always close to 2.5 billion. In 2015, the world's population is expected to 7.2 billion, global mobile phone utilization rate will reach 34.7 % (17.3).

For all the diverse high-frequency exposures occurring in environmental and occupational settings ranging from long-waves [a type of amplitude modulation (AM) broadcasting with carrier frequencies between 153 and 280 kHz] to radar waves. only a few long-term observational studies have been published (17.3). Because of the characteristics and the using methods of cell phone, the focus of attention gradually focused on the cell phone use and brain tumor risk. Many articles focus on this problem, however, the conclusion is contradictory. With the rapid development of nearly 10 years mobile phone usage, conclusions on this issue is also changing. But such

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discussions were very meaningful. In July 2011, The Lancet Oncology, the WHO's International Agency for Research on Cancer (IARC) declared that radiofrequency electromagnetic fields including mobile phone emit had bend classifyed as "possibly carcinogenic to humans" based on an increased risk of brain tumor including glioma and meningioma [3, 17, 24]. The move occured no more than a year after the huge Interphone study found no increased risk of cancer from more than a decade of mobile phone use. We tried to refine this big problem and tried to come to a conclusion with discussion and computed from different details.

The development of science and technology will surely bring some disadvantages. Whether these disadvantages will bring serious consequences is the mainly point that we need careful evaluation. Therefore, I discussed this problem from epidemiologic investigations to discuss the relationship between cell phone use and brain tumor incidence.

Materials and methods

Search strategy and selection criteria

In this meta-analysis, the recommendations of the Cochrane Handbook for Systematic Reviews of Interventions and the Quality of Reporting of Meta-Analyses statement were followed. A comprehensive search strategy was developed and the appropriate keywords were used. The databases searched included Medline, PubMed clinical trials, Web of Science (http://wok.mimas.ac.uk/), the Cochrane Database of Systematic Reviews, the Cochrane Central Register of Controlled Trials, Proceedings First and Papers First. In addition, conference proceedings, abstracts and the reference lists of other literature reviews and of all the short-listed studies were also searched. We scanned the relevant literatures in nearly decade.

Data extraction and quality assessment

Initially, 238 articles were identified from the databases used. Unsuitable articles were then eliminated in a stepwise manner, as shown in Fig. 1. First, any duplicates

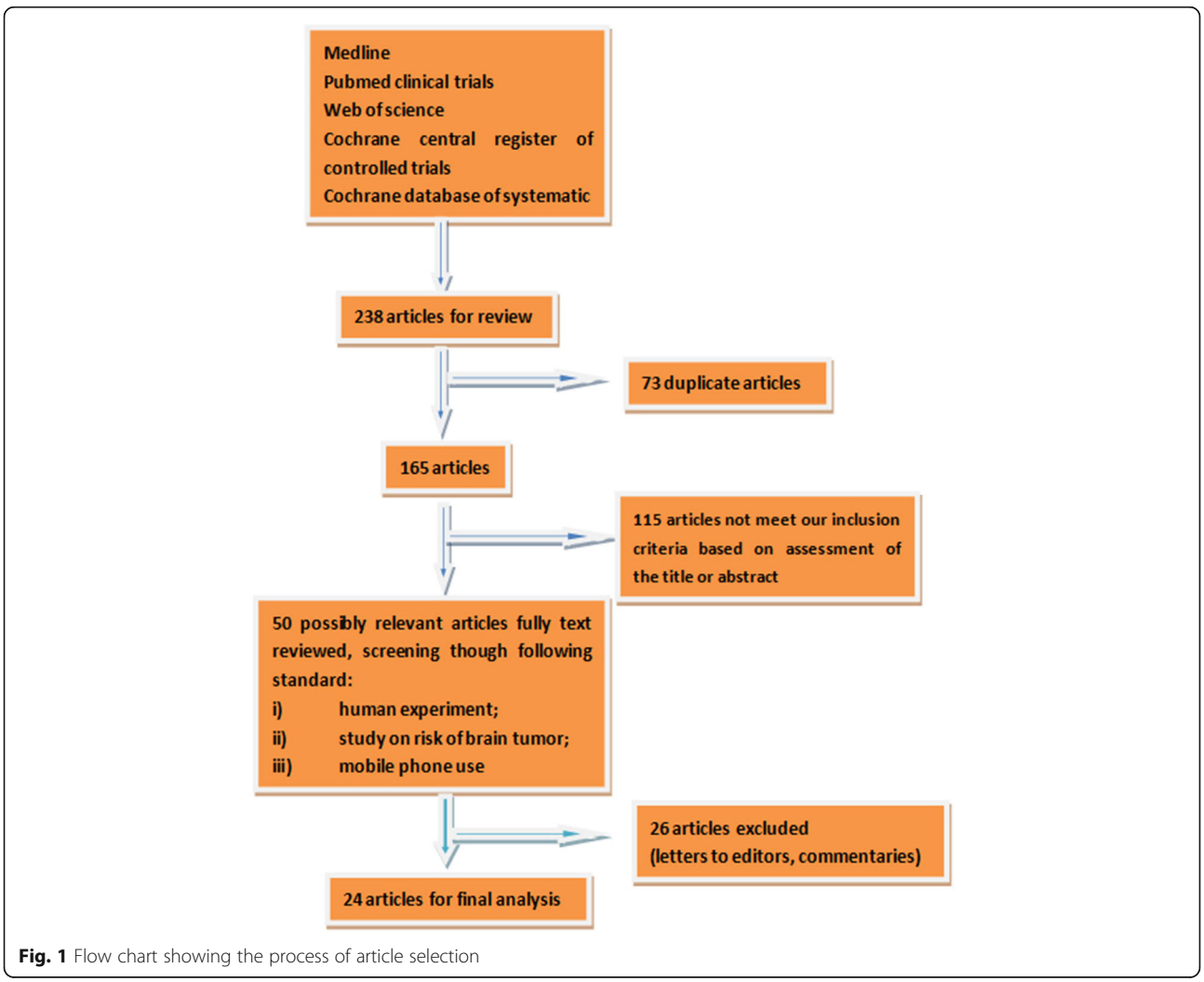


Fig. 1 Flow chart showing the process of article selection

were excluded, followed by any evidently irrelevant articles that did not meet our inclusion criteria based on assessment of the title or abstract. The remaining articles were retrieved for full-text review by one reviewer and were short-listed for final review if the following criteria were met: i) published in peer-reviewed journals; ii) study on risk of brain tumor; and iii) included participants using MPs. The full text of all the articles that were short-listed at this stage was reviewed by two independent reviewers, according to an a priori protocol. Subsequently, the agreement of the two reviewers as to whether an article should be included was assessed as the ratio of studies where agreement was reached over the total studies assessed.

We have carried out a critical examination of the protocols and results from all case–control and cohort studies, pooled analyses and meta-analyses on head tumour risk among MP users. For each study we have identified the elements that must be taken into account to ensure an impartial evaluation of its reliability. The hypothesis test for presence of heterogeneity was based on the Q test of heterogeneity, which follows a $\chi 2$ distribution. Furthermore, two measures for quantifying the impact of heterogeneity were calculated: H2 (square root of the Q heterogeneity statistic divided by its degrees of freedom) and Higgins I2 (transformation of H that describes the proportion of total variation in study estimates that is due to heterogeneity). If heterogeneity was observed, then the random-effect model was performed by incorporating an estimate of the between-study heterogeneity (DerSimonian and Laid $\tau 2$) into the weights. When the general fixed effect model was applied to each study estimate, a weight directly proportional to its precision was given (inverse variance-weighted method).

Statistical analysis

Statistical analysis of the data extracted from each eligible study was performed using the Review Manager (RevMan) software version 5.0 for Windows (The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark). Due to significant clinical heterogeneity among the eligible studies, a random effects meta-analysis was performed in order to calculate the relative risk (RR) and absolute risk with the 95 % confidence interval (CI) for mortality (if this was reported). In addition, the presence of statistical heterogeneity was investigated using the $\chi 2$ test and I2 value, with a priori-defined cutoff values of $P < 0.10$ or $I2 > 50$ %. If the cutoff values were exceeded, sensitivity analysis was performed to exclude any low-quality studies. Furthermore, funnel plots were constructed to assess the possibility of publication bias.

Results

Eligible studies

Outcomes of eligible studies

The summaries of these articles of on mobile phone use and brain tumor are in Table 1 [1, 2, 4, 5, 7–12, 14–16, 18, 20, 21, 23, 25–31]. In general, the conclusion of this article 24 is fraught with controversy and conflict, which can tell from the wide range of argument among author and readers after each article published. We can see that in the short term (10 years), the relationship between the application of mobile phones and brain tumors is not obvious. With the increasing of time (>10 years), the dangerous of application mobile phone may gradually reveal. Mobile phone rapid developed in recent ten years, perhaps with the increasing of time (>20 years), the risk of the using mobile phones will be highlighted.

(1) Different kinds of brain tumor

The summaries of these articles of on mobile phone use and different kinds of brain tumor are in Table 2. The forest and funnel plot of mobile phone use and brain tumor were in Fig. 2 ($p > 0.05$).

1) Glioma

In glioma, the situation seems to be similar to the whole brain tumor, there were not any strong evidence showed that there was a relationship between glioma morbidity and mobile phone use [2, 4, 8, 9, 11, 16, 23, 27, 30]. But with the rising of glioma malignant degree, the level III to IV glioma seems to be associated with the use of mobile phone [8, 23].

2) Meningioma

In meningioma [2, 4, 9, 11, 16, 23, 30], The use of mobile phone does not increase the incidence of meningioma.

3) Acoustic tumor and pituitary tumor

Because studies these two kinds of tumor are few, seems that cell phone use increased the incidence of acoustic tumor [2] while not much effect on incidence of pituitary tumor [30].

(2) Children and teenagers

The summaries of these articles of on mobile phone use and children and teenagers brain tumor are in Table 3. In children and teenagers, cell phone use is associated with the incidence of brain tumors [1, 10, 25, 28].

(3) Different racial types

Asian

The summaries of these articles of on mobile phone use and Asian people's brain tumor are in Table 4. Research [29, 30] shows that seems to Asian people's, cell phone use and glioma had certain relations, while has very little relationship with meningioma incidence.

Table 1 Summary of studies on mobile phone use and brain tumor

Study	Period covered	Study type	Age (years)	No.of cases	OR (95 % CI)
Söderqvis et al., 2011 [28], Nordic countries [4]	2004–2008	Case–control	7–19	352 cases; 646 controls	1.36; (0.92 to 2.02)
Elliott et al., 2010 [10], UK [5]	1999–2001	Case–control	0–4	1397 cases: 5588 controls	1.02 (0.88 to 1.20)
Takebayashi et al., 2006 [29], Japan [6]	2000–2004	Case–control	30–69	51 cases: 53 controls	0.7 (0.4 to 1.2)
Takebayashi et al., 2008 [30], Japan [7]	2000–2004	Case–control	30–69	322 cases;683 controls	1.22 (0.63–2.37) for glioma, 0.70 (0.42–1.16) for meningioma, and 0.90 (0.50–1.61) for pituitary adenoma
Schüz et al., 2006 [26, 27], Denmark [8]	1982–2002	Cohort	≥18	32	0.7 (0.5 to 1.03)
The INTERPHONE Study Group, 2010 [16], 13 countries [9]	2000–2004	Case–control	30–69	2708 glioma and 2409 meningioma cases and matched controls	glioma 0.81 (0.70–0.94) and meningioma 0.79; (0.68–0.91)
Frei et al., 2011 [11], Danish [10]	1990–2007	cohort	≥30	10729	≥13 years 1.03 (0.83 - 1.27) in men and 0.91 (0.41 to 2.04) in women. ≥10 years, glioma 1.04 (0.85 - 1.26) in men and 1.04 (0.56 -1.95) in women, meningioma 0.90 (0.57 to 1.42) in men and 0.93 (0.46- 1.87) in women
Deltour et al., 2009 [9], 4 countries [11]	1974–2003	cohort	20–79	59984	glioma 1.05 (0.98-1.08) among men and 1.02 (1.01-1.05) among women; meningioma 1.08 (0.96-1.13) among men, and 1.38 (1.32-1.44) among women
Schüz (b) et al., 2006 [26, 27], Germany [12]	2000–2003	Case–control	30–69	366 glioma cases, 381 meningioma cases, and 1,494 controls	0.98 (0.74-1.29) for glioma and 0.84 (0.62-1.13) for meningioma. ≥10 years, For glioma 2.20, (0.94-5.11); for meningioma 1.09 (0.35-3.37)
Larjavaara et al., 2011, [18] 7 countries [13]	2000–2004	case-case analyses	18–69	873 glioma cases, with 495 being regular mobile phone users and 378 reporting no regular use.	no statistically significantly
Little et al., 2012, USA [20]	1997–2008	cohort	≥18	24 813	0.98 (0.72-1.25)
Inskip et al., 2010, [15] USA [15]	1977–2006	cohort	Not mentioned	38788	Age 20–29, 1977–1991 diagnosis 2.52 (1.31, 3.76); 1992–2006 diagnosis 1.78 (0.48, 3.10)
Carlberg et al., 2013, [7] Sweden [16]	2007–2009	Case–control	18–75	709 meningioma cases and 1,368 control subjects	Mobile phone use 1.0 (0.7-1.4); cordless phone use 1.1 (0.8-1.5)
Carlberg et al., 2014, [8] Sweden [17]	1997–2003 and 2007–2009	case-case analyses	18–75	1678 glioma cases	>20 years For glioma 1.7 (1.2–2.3); astrocytoma grade IV (glioblastoma multiforme; $n = 926$) Mobile phone use 2.0 (1.4-2.9); cordless phone use 3.4 (1.04-11)
Mild et al., 2007, [23] Sweden [18]	1997–2003	Case–control	18–75	2159 cases and 2162 controls	>10 years, different kinds of brain tumor, analogue phones yielded 1.6, (1.02–2.5), digital phones 1.3, (0.5–3.2) and cordless phones 1.6, (0.9–2.8)
Hardell et al., 2013, [12] Sweden [19]	2007–2009	Case–control	18–75		1.8 (1.04-3.3) >25 years 3.3 (1.6-6.9)

Table 1 Summary of studies on mobile phone use and brain tumor *(Continued)*

				593 malignant brain tumour cases, 1368 controls	
Aydin et al., 2011, [1] 4 contries [20]	2004–2008	Case–control	7–19	352 cases and 646 controls	1.36 (0.92-2.02) >5 years 1.26 (0.7-2.28)
Hepworth et al., 2006, [14] UK [21]	2000–2004	Case–control	18–69	966 cases and 1716 controls	0.94 (0.78-1.13)
Richard et al., 2014, [25] UK [22]	2007–2009	a pilot study	0–24	49 cases and 78 controls	Response rates were 52 % for cases and 32 % for controls. Breastfeeding 0.4 (0.2-1.2) Caesarean section 1.6 (0.6-4.4).
Benson et al., 2013, [2] UK [23]	1999–2005 and again in 2009	cohort	middle-aged women	791710	1.01 (0.9-1.4) For glioma 0.78, (0.55–1.10), For meningioma 1.10, (0.66–1.84), . For acoustic neuroma, 2.46, (1.07–5.64)
Cardis et al., 2011, [5] five interphone countries [24]	2000–2004	Case–control	30–59	553 glioma and 676 meningioma cases and 1762 and 1911 controls	0.93 (0.73 to 1.18) for glioma; 0.80 (0.66 to 0.96) for meningioma
Cardis (b) et al., 2011, [5] five interphone countries [35]		Estimation of RF energy absorbed in the brain			
Zhao et al., 2007 [31] [26]		Apoptosis Genes in Primary Cultures of Neurons and Astrocytes			
Liu et al., 2015 [21] [27]		Study on cell lines, U251-MG and U87-MG			

Table 2 Summary of studies on mobile phone use and different kinds of brain tumor (glioma, meningioma, acoustic neuroma, pituitary adenoma)

Study	Period covered	Study type	Age (years)	No.of cases	OR (95 % CI)
Glioma					
Takebayashi et al., 2008, [30] Japan [7]	2000–2004	Case–control	30–69	322	1.22 (0.63–2.37)
The INTERPHONE Study Group,2010, [16] 13countries [9]	2000–2004	Case–control	30–69	1078	glioma 0.81 (0.70–0.94)
Frei et al.,2011, [11] Danish [10]	1990–2007	cohort	≥30	356	1.04 (0.85 - 1.26) in men and 1.04 (0.56 -1.95) in women
Deltour et al., 2009, [9] 4 countries [11]	1974–2003	cohort	20–79	5390	1.05 (0.98-1.08) among men and 1.02 (1.01-1.05) among women
Schüz (b) et al., 2006, [26, 27] Germany [12]	2000–2003	Case–control	30–69	257	0.98 (0.74-1.29) ≥10 years, 2.20, (0.94-5.11)
Carlberg et al., 2014, [8] Sweden [17]	1997–2003 and 2007–2009	case-case analyses	18–75	1678	>20 years 1.7 (1.2–2.3); astrocytoma grade IV Mobile phone use 2.0 (1.4-2.9); cordless phone use 3.4 (1.04-11)
Mild et al.,2007, [23] Sweden [18]	1997–2003	Case–control	18–75	905	>10 years, grade I-II 1.6 (0.6-4.1) grade III-IV 2.7 (1.8-4.2)
Benson et al., 2013, [2] UK [23]	1999–2005 and again in 2009	cohort	middle-aged women	571	0.78, (0.55–1.10),
Cardis et al., 2011, [5] five interphone countries [24]	2000–2004	Case–control	30–59	553	0.93 (0.73 to 1.18)
Meningioma					
Takebayashi et al., 2008, [30] Japan [7]	2000–2004	Case–control	30–69	322	0.70 (0.42–1.16)
The INTERPHONE Study Group,2010, [16] 13 countries [9]	2000–2004	Case–control	30–69	1147	0.79; (0.68–0.91)
Frei et al.,2011, [11] Danish [10]	1990–2007	cohort	≥30	80	≥10 years, 0.90 (0.57 to 1.42) in men and 0.93 (0.46- 1.87) in women
Deltour et al., 2009, [9] 4 countries [11]	1974–2003	cohort	20–79	3175	1.08 (0.96-1.13) among men, and 1.38 (1.32-1.44) among women
Schüz (b) et al., 2006, [26, 27] Germany [12]	2000–2003	Case–control	30–69	381	0.84 (0.62-1.13) ≥10 years, 1.09 (0.35-3.37)
Benson et al., 2013, [2] UK [23]	1999–2005 and again in 2009.	cohort	middle-aged women	251	0.78, (0.55–1.10)
Cardis et al., 2011, [5] five interphone countries [24]	2000–2004	Case–control	30–59	676	0.80 (0.66 to 0.96)
Mild et al.,2007, [23] Sweden [18]	1997–2003	Case–control	18–75	759	1.3, (0.5-3.2)
Acoustic Neuroma					
Benson et al., 2013, [2] UK [23]	1999–2005 and again in 2009	cohort	middle-aged women	96	2.46 (1.07–5.64)
Pituitary adenoma					
Takebayashi et al., 2008, [30] Japan [7]	2000–2004	Case–control	30–69	110	0.90 (0.50–1.61)

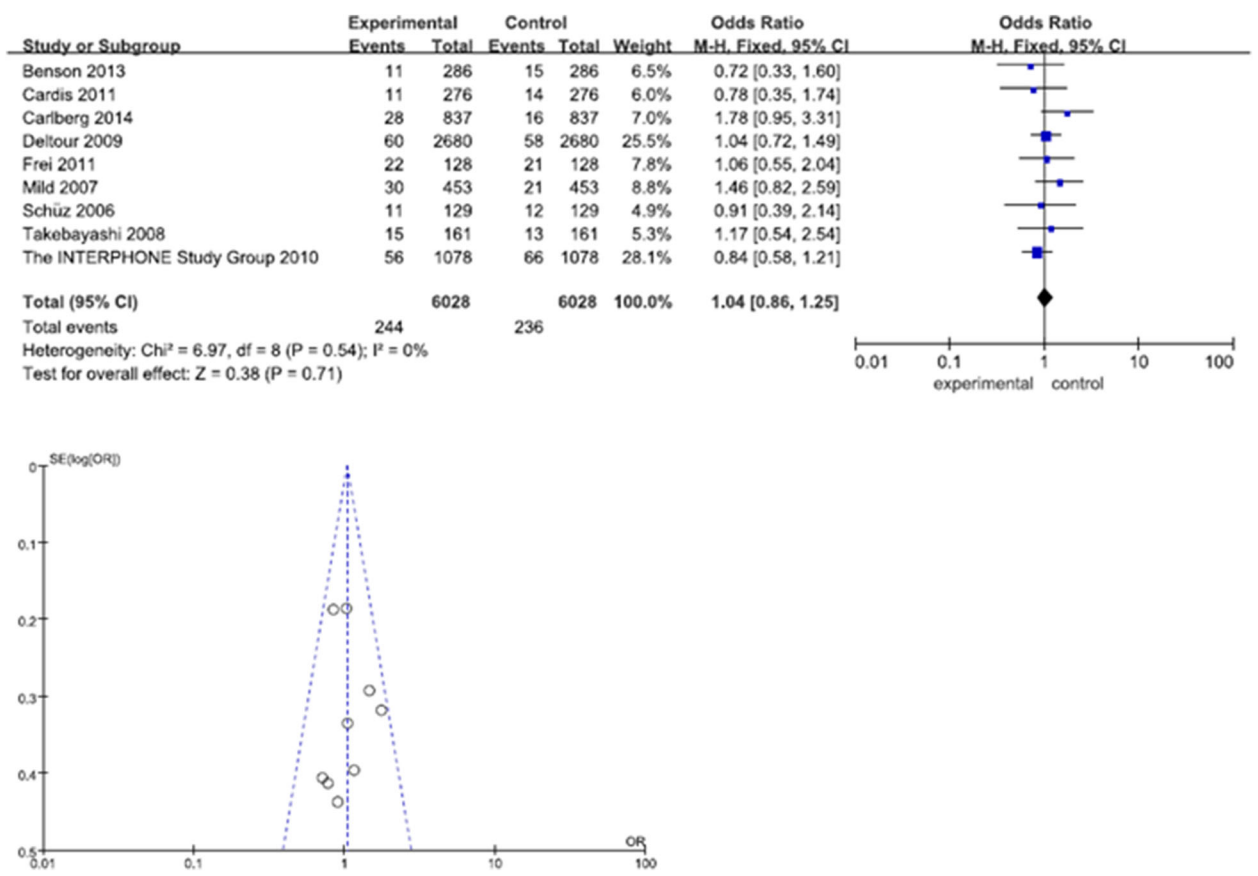


Fig. 2 The forest and funnel plot of mobile phone use and brain tumor

(4) Gender

The summaries of these articles of on mobile phone use and brain tumor on different gender are in Table 5. Research [9, 11] shows the relationship between cell phone use and brain tumor incidence had no significant difference between men and women.

(5) Cell, gene and tissue

A few articles on cells, genetic and RF energy absorbed in the brain showed [21, 31] cell phone use can increase the RF energy absorbed in the brain and apoptosis genes expression level, but glioma cell line cells were not significantly affected.

Discussion

Methodologic problems

All these articles intends to evaluated from the aspect of analytical epidemiology and tried to estimate the risk of mobile phone use by application of some frequently-used study types, such as case–control, and cohort study designs. Theoretically, all these study types are capable to detecting an existing risk under ideal conditions but actually they are influenced by many factors.

First of all, the time of using mobile phone and the distance of using mobile phone are hard to quantify. Some people might use mobile phone only one hour a day, while the others may want to use them all the time. Some

Table 3 Summary of studies on mobile phone use and children and teenagers brain tumor

Study	Period covered	Study type	Age (years)	No.of cases	OR (95 % CI)
Söderqvis et al., 2011, [28] Nordic countries [4]	2004–2008	Case–control	7–19	352 cases; 646 controls	1.36; (0.92 to 2.02)
Elliott et al., 2010, [10] UK [5]	1999–2001	Case–control	0–4	1397 cases: 5588 controls	1.02 (0.88 to 1.20)
Aydin et al., 2011, [1] 4 contries [20]	2004–2008	Case–control	7–19	352 cases and 646 controls	1.36 (0.92-2.02) >5 years 1.26 (0.7-2.28)
Richard et al., 2014, [25] UK [22]	2007–2009	a pilot study	0–24	49 cases and 78 controls	Response rates were 52 % for cases and 32 % for controls.

Table 4 Summary of studies on Asian people's mobile phone use and brain tumor

Study	Period covered	Study type	Age (years)	No.of cases	OR (95 % CI)
Takebayashi et al., 2006, [29] Japan [6]	2000–2004	Case–control	30–69	51 cases: 53 controls	0.7 (0.4 to 1.2)
Takebayashi et al., 2008, [30] Japan [7]	2000–2004	Case–control	30–69	322 cases; 683 controls	1.22 (0.63–2.37) for glioma, 0.70 (0.42–1.16) for meningioma, and 0.90 (0.50–1.61) for pituitary adenoma

people may use the earphone, while some people don't. For people who use headphones, we don't know if it will be reached a safe distance.

Second, if using mobile phones has harm to human body, it will be a small but persistent effect. This effect may be accumulated decades before causing the occurrence of brain tumor. But using mobile phones developed rapidly in nearly 10 years, we really don't know whether such frequent using will lead a sharp rise in brain tumors in the future. Now, nearly 20 years, the incidence of brain tumors was slowly rising, with fluctuations up and down.

Third, there are many different kinds of brain tumor, including glioma, accounted for about half of the brain tumor. Different types of brain tumor have different cell source, therefore have different response to radiation. Simple discussing the relationship between the incidence of brain tumors and mobile phone use may lead to a vague conclusion.

Potential biases

Most studies were undergoing based on the Interphone protocol [6] that delimited regular use as more than one outgoing or incoming call per week for at least 6 months, with ever-regular use sustaining 1 year before the reference date. Although the reference date was defined as diagnosis date in cases and the same date of the matched control, in studies not individually matched. Because of the rapid increasing in mobile phone use during and before the study period, the methods used to compute the reference date for controls may be a source of bias.

Average power levels are not much different between cordless phones (average levels of 10 mW) and mobile phones (median average output power 6–16 mW in urban areas). So the former should also be counted, different from Interphone group algorithm.

Method of data acquisition should be noted: a) interviews should be blinded to case status r; b) the interaction between interviewee and interviewer as such can lead to bias (Rosenthal effects); c) answering a questionnaire at home is less demanding may lead a bias; d) at home it is possible to check telephone bills or to inspect contracts with network providers to verify data. So face-to-face survey should be used instead of telephone survey, but due to the large numbers of survey, it's hard to do all the survey face-to-face. In some countries, the survey was conducted in the hospitals, while some of them are telephone surveys.these are all sources of bias. Different age groups and different cultures can also be the cause of bias, so we tried to reduce the bias through refine the d investigation and group the investigation population.

Results discussion

Carcinogenesis is a multistage event and the tumorigenesis depends on initiation, promotion and progression of the disease. Since the mechanism for a possible tumorigenesis effect of RF-EMF exposure is unclear, descriptive incidence data are of limited value and should currently be less important to those based on analytical epidemiology. Further researches are need on the risk of brain tumors in children associated with use of mobile phones; future researches must accord with basic demands on quality, by which we mean not only efforts taken to ensure reliable assessment of results, but also to obtain a sufficient number of cases and controls of which not just a few by modern measures have been exposed. The specific mechanism by which RF-EMF exposure might cause cancer remains unclear. Since we lack that information, any hypothesis made about exposure-response relations and the threshold of any increased risk is immature. From the results, the relationship between cell

Table 5 Summary of studies on mobile phone use and brain tumor of different gender

Study	Period covered	Study type	Age (years)	No.of cases	OR (95 % CI)
Frei et al., 2011, [11] Danish [10]	1990–2007	cohort	≥30	10729	≥13 years 1.03 (0.83 - 1.27) in men and 0.91 (0.41 to 2.04) in women. ≥10 years, glioma 1.04 (0.85 - 1.26) in men and 1.04 (0.56 -1.95) in women, meningioma 0.90 (0.57 to 1.42) in men and 0.93 (0.46- 1.87) in women
Deltour et al., 2009, [9] 4 countries [11]	1974–2003	cohort	20–79	59984	glioma 1.05 (0.98-1.08) among men and 1.02 (1.01-1.05) among women; meningioma 1.08 (0.96-1.13) among men, and 1.38 (1.32-1.44) among women

phone use and brain tumor incidence had no significant difference between men and women. Cell phone use can increase the RF energy absorbed in the brain and apoptosis genes expression level, but glioma cell line cells were not significantly affected. Most calculations of laterality show a trend of increasing risk for time since first use, cumulative duration of subscriptions, cumulative duration of calls, and cumulative number of calls. In Asian people's, cell phone use and glioma had certain relations, while has very little relationship with meningioma incidence. This result seems to be no racial difference. The severity and duration of prodromal symptoms are highly dependent on type of brain tumor; hence, such symptoms are unlikely to have occurred for long enough for the vast majority of the duration of exposure in most patients to explain the increased risk. It should also be pointed out that childhood tumors were totally different from adult tumors regarding their anatomy and histopathology. Moreover, one study on adults that presented results specifically for different types of glioma, e.g., low-grade and high-grade astrocytoma, indicated different risk patterns depending on the severity of the disease, with the highest risk being for high-grade astrocytoma. Most astrocytomas in children are of the low-grade type, relatively few being high-grade.

Conclusion

From the results, the relationship between cell phone use and brain tumor incidence had no significant difference between men and women. Cell phone use can increase the RF energy absorbed in the brain and apoptosis genes expression level, but glioma cell line cells were not significantly affected. Most calculations of laterality show a trend of increasing risk for time since first use, cumulative duration of subscriptions, cumulative duration of calls, and cumulative number of calls. In Asian people's, cell phone use and glioma had certain relations, while has very little relationship with meningioma incidence. This result seems to be no racial difference. In children and teenagers, cell phone use is associated with the incidence of brain tumors. We need longer time observation to supervise longer time (>20 years) mobile phone use whether has severe effects on incidence of brain tumor.

Abbreviations

CI: Confidence interval; IARC: International Agency for Research on Cancer; RR: Relative risk;

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Availability of data and materials

Not applicable.

Author's contributions

LL carried out the whole process which was from the conception to written. Only the authors listed on the manuscript contributed towards the article.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable.

Ethics approval and consent to participate

Not applicable.

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