CELL PHONES USAGE AND CANCERS: A REVIEW

Ahmad Farhan A.F.¹ Hejar A.R.¹, Edre M.A.¹,²

¹Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia
²Trainee Lecturer, Department of Community Medicine, Kulliyyah of Medicine, International Islamic University Malaysia

*Corresponding author: Dr. Ahmad Farhan bin Ahmad Fuad, Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang. Email: drmaesch@yahoo.com

ABSTRACT

Background: Certain electromagnetic fields (at extremely low frequency) have been recognized as possibly carcinogenic by the International Agency for Research on Cancer. Given the use of radiofrequency technology in cell phones, the rapid increase in the number of cell phones has generated concerns about the existence of a potential health hazard. Use of cellular telephones is increasing exponentially and has become part of everyday life. Concerns about possible carcinogenic effects of radiofrequency signals have been raised, although they are based on limited scientific evidence. Thus, a scoping systematic review was to ascertain this.

Materials and Methods: Full-text articles on Cohort studies and/or randomized controlled trials published from 1st January 2000 to 8th June 2016 were searched using Proquest and other sources. People of all age group and cellular phones users were the type of participant and exposure used for the search strategy, respectively. Data collection was done by 1 reviewer and checked by 2 reviewers for discrepancies. All the papers were critically appraised using the STROBE statement. Qualitative synthesis was done by descriptive comparison, risk of bias comparison and effect of exposure comparison.

Result: 5 out of 15 articles met the eligibility criteria and were selected. Four articles showed low risk of bias due to low confounding bias. One article had high risk of bias due to information bias. All five articles showed low quality evidences using GRADE. There was no evidence for a dose–response relationship for these cancers based on number of years as a subscriber. Analyses by anatomic location of the brain tumors within the head revealed no unusual clustering that could be related to increased exposure to RF radiation from cellular telephones. The absence of statistically significant increases in cancer risks applied equally to analogue and digital systems. Therefore, it can be said that there is no association of exposure with the studied cancers.

Conclusion: There was no insufficient evidence to implicate and suggest that the usage of cell phones exposure towards cancer occurrence. All studies showed that exposure to cell phone usage, regardless the time of exposure, the onset or the duration can give a significant results of association towards cancer. However, due to small number of studies obtained from this scoping systematic review, results from this review should be interpreted with caution.

Keywords: Cellular phone, electromagnetic field, cancer, cohort studies, EMF.
1.0 Introduction

Cancers figure among the leading causes of morbidity and mortality worldwide, with approximately 14 million new cases and 8.2 million cancer related deaths in 2012. The number of new cases is expected to rise by about 70% over the next 2 decades (World Cancer Report, 2014). Certain electromagnetic fields (at extremely low frequency) have been recognized as possibly carcinogenic by the International Agency for Research on Cancer. Given the use of radiofrequency technology in cell phones, the rapid increase in the number of cell phones has generated concerns about the existence of a potential health hazard (Hours et al., 2007).

An electromagnetic field (also EM field) is a physical field produced by electrically charged objects. It affects the behavior of charged objects in the vicinity of the field. The electromagnetic field extends indefinitely throughout space and describes the electromagnetic interaction. It is one of the four fundamental forces of nature (the others are gravitation, weak interaction and strong interaction) (Richard F., 1970).

Use of cellular telephones is increasing exponentially and has become part of everyday life (Inskip et al., 2001). Concerns about possible carcinogenic effects of radiofrequency signals have been raised, although they are based on limited scientific evidence. Thus, a scoping systematic review was to ascertain this.

2.0 Materials and Methods

2.1 Objectives

The primary objective of this scoping review is to determine evidences supporting the usage of cell phones as a determinant of cancer. Secondary objectives would be to determine what type of cancer involved in association with the usage of cell phones.

2.2 Methods

Criteria for considering studies for this review:

a. Types of studies

   Cohort and/or randomized controlled trial (RCT) study designs were considered.

b. Types of participants

   People of all age groups were considered

c. Types of interventions

   Usage of cell phone exposures as intervention was considered.
2.3 Search methods for identification of studies (including PRISMA flowchart)

All studies published from 1st January 2000 to 8th June 2016, were searched using Proquest, Scopus and other sources. Only full text articles were taken. The total search result was 13 in Proquest, 5 in Scopus and 2 from other sources. Three elements of the search strategy were developed using the Boolean term ‘AND’ or ‘OR’:

1. Exposure subject heading: Document text (ft) (cellular phones) AND
2. Disease subject heading: ft ((Cancer OR Neoplasm)) AND
3. Study design subject heading: Document title (ti) ((Cohort OR Randomized controlled trial))

2.4 Data collection and analysis

Data collection was done by 1 reviewer and checked by 2 reviewers. All the papers were critically appraised using the STROBE statement.

Qualitative synthesis was done by descriptive comparison, risk of bias comparison and effect of exposure comparison. Meta-analysis was not done due to difficulty in obtaining some of the estimates which were not reported in the articles.

3.0 Result

3.1 Descriptive studies

Table 1: Descriptive studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Study design</th>
<th>Sample size</th>
<th>Population</th>
<th>Period (year)</th>
<th>Exposure</th>
<th>Cancer outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inskip et al., 2001</td>
<td>Case control study</td>
<td>1581</td>
<td>Patient who came at hospitals in Boston (Brigham and Women's Hospital); Phoenix, Arizona (St. Joseph's Hospital and Medical Center); and Pittsburgh (Western Pennsylvania Hospital), where there are the referral center for the diagnosis and treatment of brain tumors.</td>
<td>June of 1994 and ended in August of 1998</td>
<td>Use of hand-held cellular telephones</td>
<td>Glioma Meningioma Acoustic Neuroma</td>
</tr>
<tr>
<td>Johansen et al., 2001</td>
<td>Retrospective cohort</td>
<td>420,095</td>
<td>Danish population using cell phones</td>
<td>1982 through 1995</td>
<td>Cellphones usage</td>
<td>Any type (did not specified)</td>
</tr>
<tr>
<td>Auvinen et al., 2002</td>
<td>Case control study</td>
<td>398</td>
<td>Cancers diagnosed in patients between 20 and 69 years of age in Finland in 1996 from the population-based Finnish Cancer</td>
<td>1996</td>
<td>Analog transmitting constant RF signal or digital transmitting</td>
<td>Brain tumors Salivary gland cancer</td>
</tr>
</tbody>
</table>
### 3.2 Risk of bias in included studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Exposure assessment bias</th>
<th>Selection bias</th>
<th>Randomization bias</th>
<th>Confounding</th>
<th>Other bias</th>
<th>Overall risk of bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inskip et al., 2001</td>
<td>Low</td>
<td>Low due to all patient who came to hospital were taken</td>
<td>Not applicable</td>
<td>Low</td>
<td>Unclear</td>
<td>Low</td>
</tr>
<tr>
<td>Johansen et al., 2001</td>
<td>Low</td>
<td>High due to only Danish population in general</td>
<td>Not applicable</td>
<td>High due to low statistical power and no description on control of confounders</td>
<td>High due to information bias</td>
<td>High</td>
</tr>
<tr>
<td>Auvinen et al., 2002</td>
<td>Low due to detailed description given</td>
<td>Low due to specified diagnosed cases with specific age group</td>
<td>Not applicable</td>
<td>Low due to stratification by age and gender done</td>
<td>low</td>
<td>Low</td>
</tr>
<tr>
<td>Lönn et al., 2004</td>
<td>Low</td>
<td>Low due to specified diagnosed cases with specific age group</td>
<td>Not applicable</td>
<td>Low due to stratification by age and gender done</td>
<td>low</td>
<td>Low</td>
</tr>
<tr>
<td>Cardis et al., 2007</td>
<td>Low due to detailed description given</td>
<td>High due to multinational group</td>
<td>Not applicable</td>
<td>Low due to analysis adjusted for covariates and possible confounding effects of symptoms of diseases</td>
<td>Symptoms of diseases</td>
<td>Low</td>
</tr>
</tbody>
</table>
region, age and sex had been taken into account systematically by the matching of cases and controls.

Table 2 depicts the risk of bias in reviewed studies. The overall risk of bias is based on the author’s judgment and discussion with other reviewers for this systematic review.

### 3.3 Effect of exposure

**Table 3: Effect of exposure**

<table>
<thead>
<tr>
<th>Author</th>
<th>Selected Outcome</th>
<th>Group</th>
<th>Relative effect (95% CI)</th>
<th>No of cases</th>
<th>Quality of evidence using GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inskip et al., 2001</td>
<td>Glioma Meningioma Acoustic Neuroma</td>
<td>No mention</td>
<td>Not mention</td>
<td>Relative risk was 1.2 (P=1.00).</td>
<td>1581</td>
</tr>
<tr>
<td>Johansen et al., 2001</td>
<td>Any type (did not specified)</td>
<td>Not mention</td>
<td>Not mention</td>
<td>Significantly decreased standardized incidence ratio (SIR) of 0.89 (95% confidence interval CI = 0.86 to 0.92).</td>
<td>420,095</td>
</tr>
<tr>
<td>Auvinen et al., 2002</td>
<td>Brain tumors Salivary gland cancer</td>
<td>Unclear</td>
<td>Unclear</td>
<td>Odds ratios of 1.3 (95% CI 0.9–1.8) for brain tumors and 1.3 (95% CI 0.4–4.7) for salivary gland cancers</td>
<td>398</td>
</tr>
<tr>
<td>Lönn et al., 2004</td>
<td>Acoustic neuromas</td>
<td>Not mention</td>
<td>Not mention</td>
<td>Ten years after the start of mobile phone use the estimates relative risk increased to 1.9 (0.9–4.1); when restricting to tumors on the same side of the head as the phone was normally used, the relative risk was 3.9 (1.6–9.5).</td>
<td>752</td>
</tr>
<tr>
<td>Cardis et al., 2007</td>
<td>Glioma Meningioma Acoustic neuroma Malignant parotid gland tumor</td>
<td>Unclear</td>
<td>Unclear</td>
<td>Unclear</td>
<td>14,078</td>
</tr>
</tbody>
</table>

Only 4 studies showed selected outcome results with significant P value (<0.05) that were chosen for the effect of exposure analysis as in table 3. Another 1 study had no significant
selected outcome. For the quality of evidence using GRADE, it is based on the combination of risk of bias judgment and the effect of intervention judgment.

4.0 Discussion

Few epidemiologic studies have been published on the effects of cellular phone use on cancer risk. But almost none found strong association between brain tumors, or any other type of tumors or cancer related to use of cellular phones. There was little or no indication of an increased risk of glioma, meningioma, or acoustic neuroma associated with any use, cumulative use, or the laterality of use of these telephones.

4.1 Descriptive studies

From all 5 studies, 4 of them was case control study and 1 retrospective cohort where it held the biggest sample size of all (Johansen et al., 2001). Of all 5, only 2 studies specifically measure the exposures of RF while the rest just mentioning about the exposure of cell phones usage. For the time of onset of disease, it was a disadvantages for all 5 studies where it could not determine exactly the time of disease onset, where it could be done with a prospective cohort rather than case-control or retrospective cohort, and multiple disease outcomes can be studied. However in term of course, case control study and also retrospective cohort were relatively cheaper than prospective cohort design in term of cost. Out of 5 studies, 3 studies took patients diagnosed with cancers while the other 2 uses population based registries. All of the studies look into common cancer which was brain cancer, where they are then specified into anatomical parts of the brain.

Low sensitivity and specificity of exposure tend to attenuate exposure effect. However, 50% sensitivity in exposure assessment would have attenuated the effect by only about 10%, assuming a reference exposure prevalence of 20% and a true OR of 1.1–2.0 (Auvinen et al., 2002).

Study by Lönn et al. in 2004 shows results for short-term use in agreement with the majority of previous studies. The only study that has reported an increased risk of acoustic neuroma among short-term mobile phone users has been criticized for limitations in methods, analysis, and presentation of the study (NRPB, 2003). All previous studies have few subjects with long term exposures, including the recently published Danish case-control study, which is also part of the INTERPHONE project.

There was no evidence for a dose–response relationship for these cancers based on number of years as a subscriber. Analyses by anatomic location of the brain tumors within the head revealed no unusual clustering that could be related to increased exposure to RF radiation from cellular telephones. The absence of statistically significant increases in cancer risks applied equally to analogue and digital systems. Therefore, it can be said that there is no association of exposure with the studied cancers (Johansen et al., 2001).

There was little or no indication of an increased risk of glioma, meningioma, or acoustic neuroma associated with any use, cumulative use, or the laterality of use of these telephones. There was no significantly increased risk associated with the use of cellular telephones at any of the three centers, and estimates of the relative risk associated with the use of cellular
telephones were insensitive to the inclusion or exclusion of any of the four principal subgroups of controls (Inskip et al., 2001).

4.2 Risk of bias

Out of 5 studies that had been reviewed, 4 of them showed low risk of bias (Inskip et al., 2001; Auvinen et al., 2002; Lönn et al., 2004; Cardis et al., 2007). All three articles had low exposure assessment and low confounding bias. It is very important to the author to describe the exposure in detail. Confounding biases were also low for all 4 studies when they mentioned to control it during analysis phase.

4.3 Effect of intervention

The quality of evidence using GRADE can be classified into high, moderate, low or very low, and it is based on evaluation of both risk of bias and effects of exposure. For this review, all 5 studies showed low quality evidences in linking the association of cell phones usage with cancers. It can be concluded that all studies revealed no strong linkage between them.

5.0 Conclusion and recommendation

The authors conclude that there were no insufficient evidence to implicate and suggest that the usage of cell phones exposure towards cancer occurrence. All studies showed that exposure to cell phone usage, regardless the time of exposure, the onset or the duration can give a significant results of association towards cancer. However, due to small number of studies obtained from this scoping systematic review, results from this review should be interpreted with caution. Meta-analysis could not be done as the studies were too heterogeneous.

Implications for practice

It cannot be concluded to advise the population from using the cell phones as it is an essential tools in everyday basis of life. However, a systematic surveillance should put in place to detect any abnormalities during the exposure of cell phones usage among the population.

Implications for research

Further research is warranted using:

- Different kind of phones coverage (GSM, 2G, 3G, 4G, LTE)
- Different target population
- Longer duration of follow-up cohorts
- Robust statistical analysis to control for most of the confounders
- Experimental study designs for individual studies
- Meta analysis of high-quality RCTs
In addition, ethical considerations should always be applied here, especially in experimental study designs such as RCTs.

**Acknowledgement**

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**Declaration**

Authors declare that there were no conflicts of interest.

**Authors contribution**

Author 1: Literature review, planning research activities and executing the research activities including data collection

Author 2: Contributing in methodological aspects, planning the research activities and analysis aspect of this research including reviewing for study data discrepancies

Author 3: Contributing in methodological and analysis aspects of the research including reviewing for study data discrepancies

**References**


