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# Association between media coverage and prevalence of idiopathic environmental intolerance attributed to electromagnetic field in Taiwan

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## ABSTRACT

Idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) describes symptoms sufferers attribute to exposure to electromagnetic fields (EMF). In Taiwan, the prevalence rate of IEI-EMF was 13.3% in 2007, but a survey using the same method found the rate declined to 4.6% in 2012. Because media reports may encourage readers to attribute their symptoms to EMF, the change might be related to media coverage. We searched articles indexed in the largest newspaper database in Taiwan to evaluate the association between media coverage and the prevalence of IEI-EMF. We also assessed the effects of other potential affecting factors. The number of newspaper articles related to EMF and IEI-EMF increased from 2005 to 2007 and then has been decreasing until 2012, which is compatible with the change in the prevalence of IEI-EMF. However, from 2007 to 2012, the other potential affecting factors such as density of mobile phone base stations, number of mobile phone users, total mobile phone calling time, and number of text messages sent through mobile phones all increased in Taiwan. This finding indicated a positive association between media coverage and the prevalence of IEI-EMF in Taiwan, which might also be true in other countries.

## 1. Introduction

Nowadays people are inevitably exposed to electromagnetic fields (EMF) because of the ubiquitous usage of electrical devices, such as mobile phones, microwave ovens, televisions, etc. The World Health Organization (WHO) coined the term “idiopathic environmental intolerance attributed to electromagnetic fields” (IEI-EMF) in 2005 to describe symptoms that people attribute to the existence of EMF (WHO, 2005), which include insomnia, headache, anxiety, skin itching, tinnitus, vomiting, etc. (Baliatsas et al., 2012). However, these symptoms are hardly attributable to the exposure of EMF on the basis of biological evidence. Sufferers of IEI-EMF with severe symptoms may not function normally in daily life and thus may try to shield themselves from exposure to EMF. These behaviors may hinder the sufferers' interactions with the society and thus lower their job performances, which finally contribute to the loss of jobs in some cases (Leitgeb and Schröttner, 2003). Therefore, even though the clinical standards of diagnosing IEI-EMF have not been established, it is recognized as a disability in Sweden (Johansson, 2015).

Although the health effects of EMF have been studied for decades, no reliable findings have been obtained to support that short-term EMF

exposure can evoke the IEI-EMF-like symptoms (Rubin et al., 2010, 2011; Kwon and Hämäläinen, 2010; Rööslä et al., 2010). In fact, many studies have been conducted to examine the ability of human beings to detect the existence of EMF, but no convincing evidence has been obtained (Hietanen et al., 2002; Lyskov et al., 2001; Rööslä, 2008; Rubin et al., 2011). At present, uncertainties concerning the potential health effects of exposure to EMF remain an important public issue.

Substantial prevalence rates of IEI-EMF have been reported from many countries around the world. In Sweden, the rate was 1.5% in 1997 (Hillert et al., 2002) and grew to 2.6–3.2% in 2001 (Ahlbom et al., 2001; Johansson, 2006). In Austria, the rate was 2% reported in 1994 (Leitgeb, 1994; Schröttner and Leitgeb, 2008) and grew to 3.5% in 2008 (Schröttner and Leitgeb, 2008). Because of these increasing trends, some researcher predicted that the rate would reach 50% worldwide in 2017 (Hallberg and Oberfeld, 2006). Contrary to the prediction, however, a population-based survey conducted in Taiwan found the prevalence rate of IEI-EMF to be 4.6% in 2012 (Cheng, 2014), a substantial decline from the 13.3% rate observed in a survey in 2007 using the same study method (Tseng et al., 2011). The decreasing prevalence of IEI-EMF contradicts the increased trends of wireless device use. Therefore, there must be some factors other than EMF that contribute to

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the occurrence of IEI-EMF.

Messages conveyed by media reports may influence risk perceptions of the public (Combs and Slovic, 1979). A study in Canada found that readers might be affected by the fright factors mediated from the newspaper coverage (Deignan et al., 2013). Another study has shown that poor reporting by the media had the potential of encouraging people to misattribute their symptoms to EMF (Witthöft and Rubin, 2013). An analysis of the contents of Norwegian newspapers found that 65% of the newspaper articles related to etiology of IEI-EMF conveyed the message that symptoms are associated with exposure of EMF below the international guidelines, which is much in conflict with the current evidence in the field (Huiberts et al., 2013). A similar content analysis of British newspaper assessed whether newspaper reporting reflected scientific evidence and found that of the random sample of 60 articles, 71.7% presented a mainly electromagnetic cause (Eldridge-Thomas and Rubin, 2013). The authors concluded that the media establishes the connection between EMF exposure and the symptoms of IEI-EMF without considering the fact that the connection is only bolstered by weak scientific evidence. They also found that articles quoting someone with IEI-EMF were more likely to report an electromagnetic cause and articles using a scientist as a source were more likely to present a non-electromagnetic cause. Consequently, the authors argue that the widespread poor reporting had the potential to encourage more people to misattribute their symptoms to electromagnetic fields. Therefore, we conducted a study to assess the changes in some potential contributing factors to the prevalence of IEI-EMF, including media coverage, and we evaluate their associations with the prevalence of IEI-EMF.

## 2. Materials and methods

We assessed changes in two major potential contributing factors for IEI-EMF over time, the exposure to EMF and the media reports of the EMF, and compared their trends to the trend of the prevalence of IEI-EMF.

### 2.1. Exposures to mobile phones and base stations

To assess the exposure of the Taiwanese population to EMF from mobile phones and their base stations, we collected data on four indicators from National Communications Commission (NCC), including mobile phone calling time, density of base stations, number of mobile phone accounts, and number of text messages (TMS). As the authority responsible for regulating telecommunications and broadcasting services in Taiwan, NCC has the most comprehensive and accurate nationwide statistical data on telecommunications. These data are published on the official website of the agency (National Communications Commission, 2017), and the statistics on mobile phone services date as far back as 1998. As the data are open to the public, they have been used by researchers to evaluate the effects of EMF (Hsu et al., 2013).

We collected data from 2005 to 2012 but excluded those on outlying islands. The density of mobile phone base stations was estimated by dividing the number of base stations in a given administrative region by the size (in km<sup>2</sup>) of that region.

### 2.2. Media reports

We searched the newspaper database “News Knowledge Database (Tudor Tech Systems Co., Ltd.),” which collects information from the 10 major newspapers in Taiwan that cover more than 95% of the newspaper sale in the country. Taiwan is a relatively small geographic area with convenient transportation, and therefore all the 10 newspapers included in the database are distributed nationwide, although some of them may have more subscribers in certain geographic areas. Of the 1345 articles included in our analyses, 20 (1.5%) were from newspapers with more localized focuses. The computerized database contains headlines and abstracts of the newspapers with links to the full

texts and images, which date back to 2002. We searched for articles from 2005 to 2012 using the keywords “base station,” “mobile phone,” and “electromagnetic field.” According to the contents, we categorized articles into seven categories: “Confrontation” covering conflicts related to the installation of base stations or power lines in the country, “Government Policy” covering issues related to governmental policy on EMF and regulation of the EMF exposure, “Telecommunication Company” covering news of the telecommunication and electric power company handling the public's fear of EMF exposure, “International News” covering news originated from outside Taiwan, “Environmental Groups” covering activities of the non-official environmental protection groups in Taiwan, “Commercial Products” covering commercial products available in Taiwan that claimed to be capable of protecting individuals from exposures to EMF, and “Others” (Claassen et al., 2012; Eldridge-Thomas and Rubin, 2013).

In addition, because media reports may affect the reader's attitudes (Vasterman et al., 2008), we also studied the implications conveyed by the newspaper articles. We categorized the articles according to the implications of their messages. Articles were categorized as “negative,” if they conveyed negative messages, such as claiming that EMF is detrimental to human health, or suggested that the public avoid or reduce their exposures to EMF. The remaining articles were categorized as “others,” because few of them reported beneficial health effects of EMF exposure or encouraged increased EMF exposure.

Two members of the research team categorized the articles independently, and the final decisions on articles with inconsistent messages were made by consensus. Inter-observer agreements were assessed by using the Cohen's Kappa test (Cohen, 1960; Viera and Garrett, 2005). Annual variations of EMF exposure indicators and media coverage were presented in figures. The Cohen's Kappa test showed excellent agreement between the two raters in the classifications of both the contents of the media reports (kappa = 0.85,  $p < 0.0001$ ) and the implications they conveyed (kappa = 0.75,  $p < 0.0001$ ).

### 2.3. Statistical analysis

To assess the time trends in EMF exposure indicators and media reports, univariate linear regressions were applied. With an EMF exposure indicator or media reports in a given category as the outcome variable and the calendar year as the predictor variable, the regression model evaluate if a stable time trend exists across the years. The differences among the proportions of newspaper articles in the categories of media reports in all the reports (expressed as percentage) were evaluated by chi-square tests. Through the Bonferroni procedure, we set the significance level at 0.0024.

## 3. Results

### 3.1. Indicators of exposures to mobile phones and base stations

The density of base stations in Taiwan increased annually from 0.24 per km<sup>2</sup> in 2005 to 0.46 per km<sup>2</sup> in 2012, at a rate of 3.12 station/km<sup>2</sup> per year ( $p = 0.0020$ ) on average (Fig. 1).

The number of mobile phone accounts also increased annually, from 22.2 million in 2005 to 29.5 million in 2012, at a rate of 1.99 million per year ( $p < 0.0001$ ) on average. The total length of mobile phone calling time increased every year from 288.7 billion minutes in 2005 to 434.8 billion minutes in 2012, at a rate of 23.1 billion minutes per year ( $p < 0.0001$ ) on average. Likewise, the number of text messages increased every year from 27.96 billion in 2005 to 85.41 billion in 2012, at a rate of 8.15 billion per year ( $p < 0.0001$ ) on average. However, the prevalence rate of IEI-EMF declined from 13.3% in 2007 to 4.6% in 2012.

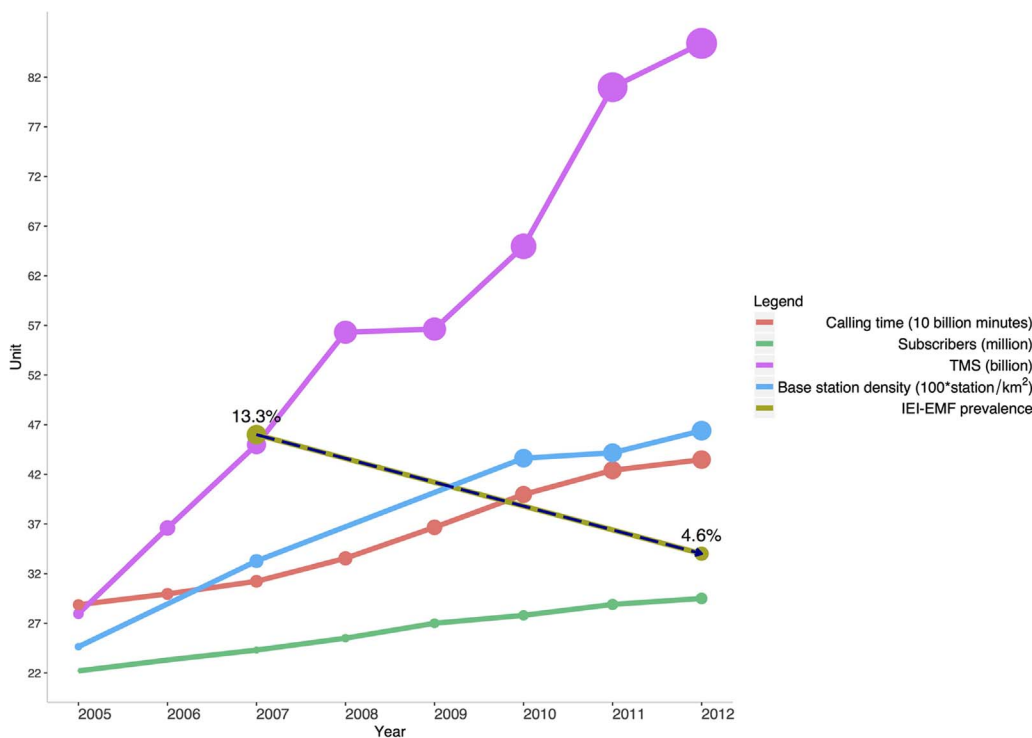


Fig. 1. Indicators of exposures to electromagnetic field and prevalence of idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) over the years. \*The dashed line represents the prevalence of IEI-EMF, which declined from 13.3% in 2007 to 4.6% in 2012. TMS: text messages. On average, subscribers increased by 1.99 million per year ( $p < 0.0001$ ), TMS increased by 8.15 billion per year ( $p < 0.0001$ ), base station density increased by 3.12 station/km<sup>2</sup> per year ( $p = 0.0020$ ), and calling time increased by 23.1 billion minutes per year ( $p < 0.0001$ ).

### 3.2. Newspaper coverage

We retrieved 3274 newspaper articles initially and excluded 1929 unrelated ones, leaving 1345 in the analysis (Fig. 2).

The largest category was “Confrontation,” which included 655 articles and made up 48.7% of all the articles. The smallest was “Commercial Products,” which included 81 articles and made up 6.1% of all articles (Fig. 3).

The number of newspaper articles increased from 2005 to 2006 in all categories, decreased rapidly until 2008, and then remained similar afterwards (Fig. 4).

The trend was in line with the declining trend of the prevalence of IEI-EMF. Specifically, the first nationwide survey of the prevalence rate of IEI-EMF that covered the whole Taiwan area was conducted in 2007, one year after the peak of the number of newspaper articles, and found the rate was 13.3%; however, the second nationwide survey found the rate had declined to 4.6% in 2012.

We found there were many more (more than 90%) newspaper articles conveying “negative” messages than those conveying “other” messages ( $p < 0.0001$ ) (Fig. 5).

The following three categories had the highest proportions of negative articles: “Confrontation,” “Environmental Groups,” and “Government Policy” ( $p < 0.0001$  for the chi-square test).

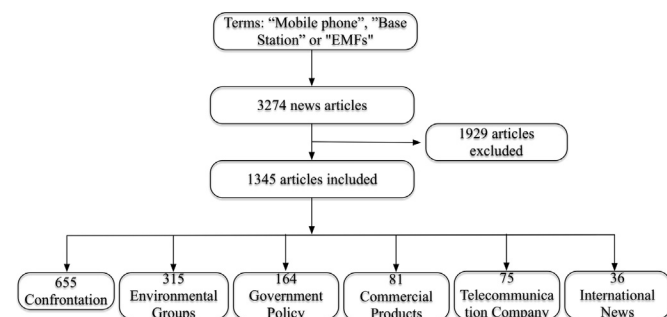


Fig. 2. Media coverage searching results.

### 4. Discussion

We found that the trend of media coverage, as reflected by the number of newspaper articles, was in line with the trend of the prevalence rate of IEI-EMF in Taiwan. We also found that articles related to IEI-EMF peaked at 2006 and then dropped dramatically in 2007 (Fig. 4), and this finding is similar to that observed in a content analysis of newspaper reports in UK which found that articles related to IEI-EMF peaked at 2007 and then dropped dramatically in the next year (Eldridge-Thomas and Rubin, 2013). A case study found that media reports that consist of assertions from a layman are more likely to affect the readers’ attitudes in comparison with those consist of assertions from a technical expert (Vasterman et al., 2008). Furthermore, the content analysis of newspaper reports in UK found that articles quoting IEI-EMF suffers of as a source of information were more likely to attribute the cause of IEI-EMF to EMF than those using scientists as a source. Taking these two study results into consideration, we infer that when affected by newspaper articles, readers are more likely to attribute IEI-EMF to EMF exposure. In fact, authors of the UK report deduced the media possibly had the direct contribution to the growing prevalence by approving the cause of symptoms identified by the IEI-EMF sufferers (Eldridge-Thomas and Rubin, 2013). Therefore, it is reasonable to see a decline in the prevalence rate of IEI-EMF when the number of newspaper articles related to IEI-EMF decreases, as observed in our study.

Unlike the newspaper articles on EMF in the UK, where 36.7% of them used scientists as a source of information (Eldridge-Thomas and Rubin, 2013), or the Netherlands, where 11% of them were in the “Scientists/technicians” frame (Claassen et al., 2012), those in Taiwan that were based on scientific evidence were very limited. Articles in the “Confrontation” category took up nearly half (48.7%) of all articles. Most of the articles covered news on the conflict events related to the construction of base stations, high voltage power plant towers, and radar stations. Almost all of the articles in this category conveyed negative messages (Fig. 5), and many of them cited journalists’ statements instead of statements from scientists. The “Environmental Groups” had the second largest number of articles. These groups vigorously incited the public’s concerns about environmental issues and successfully

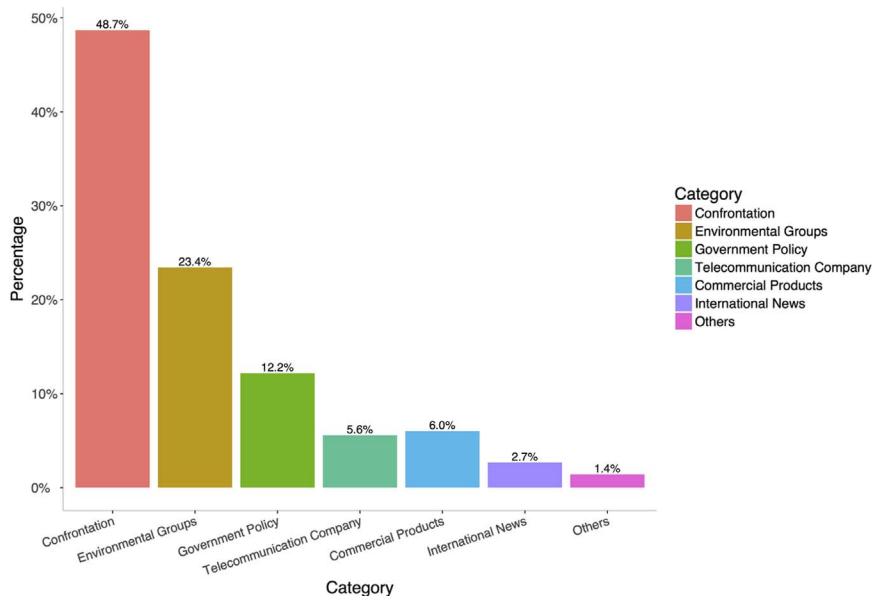


Fig. 3. Proportion of media coverage in each category.

aroused some specific concerns in Taiwan, including the potential health hazards of EMF. Most leaders of these groups are not scientists specialized in the field of EMF. Therefore, it is not surprising that around 84% of the articles in this category conveyed negative messages. The third largest category, “Government Policy,” had a similar proportion (around 83%) of articles conveying negative messages. A large fraction of these articles were on the government’s responses to the public’s actions or concerns, and many of them were initiated by environmental groups. Therefore, most of them were considered as conveying negative messages. Of all the categories, “International News” had the most balanced distributions of “negative” and “other” articles. However, it also had the smallest number of articles next only to the “Others” category. Similar to our study results, a content analysis of newspapers in Norway (Huiberts et al., 2013) also found that 65% of the articles were classified as “con evidence,” which means that they

contained statements supporting EHS symptoms are associated with exposure of EMF sources below the international guidelines.

A study reviewing newspapers in Germany and America also found that media tended to highlight the differences in opinions to make the stories controversial and thus attract an audience (Dunwoody and Peters, 1992). Their study also found that journalists’ statements might distort scientific evidences and thus mislead the audiences. In an experiment designed to evaluate the correlation between audiences’ judgment on the truth and the nature of the information conveyed by the newspaper, the investigators found that the percentage of audiences judging an input of negative information as truth was higher than the percentage of audiences judging an input of positive information as truth (Hilbig, 2009). They also found that readers paid more attention to the negative information than to the positive information. Results from those studies support our observation of an association between

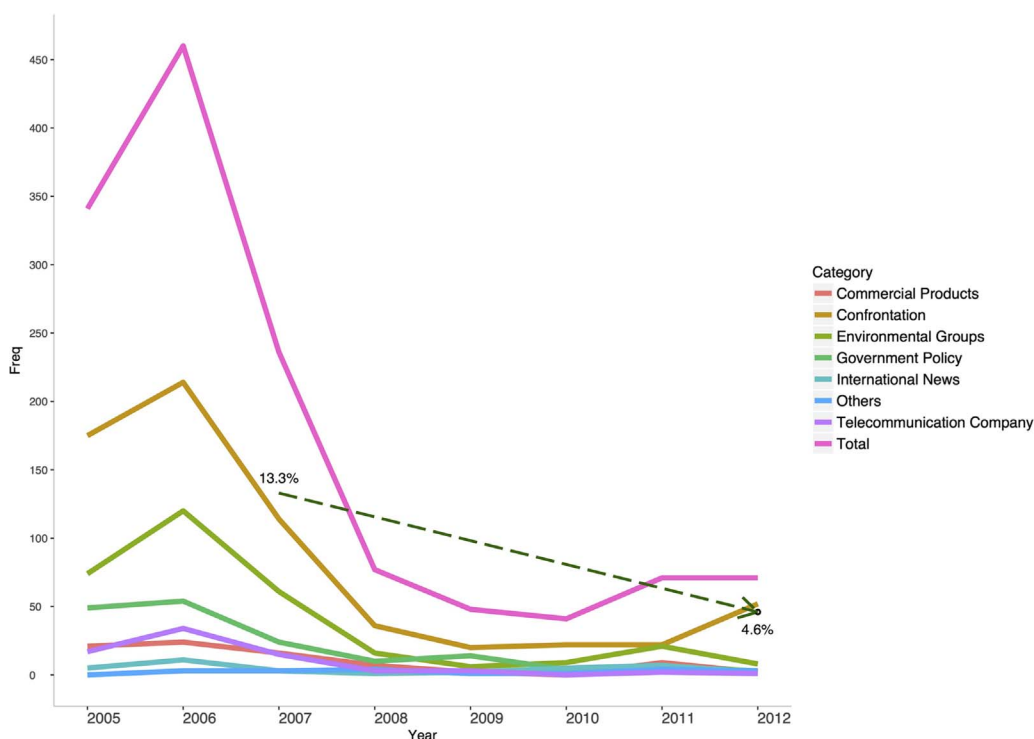


Fig. 4. Decreasing trends of newspaper categories since 2006. \*The dashed line represents the prevalence of electromagnetic hypersensitivity, which declined from 13.3% in 2007 to 4.6% in 2012. On average, Confrontation articles decreased by 25.16 per year ( $p = 0.0163$ ), Environmental Groups articles decreased by 13.37 per year ( $p = 0.0200$ ), Government Policy articles decreased by 7.36 per year ( $p = 0.0033$ ), Telecommunication Company articles decreased by 3.77 per year ( $p = 0.0232$ ), Commercial Products articles decreased by 3.11 per year ( $p = 0.0111$ ), and International News articles decreased by 0.40 per year ( $p = 0.4689$ ).



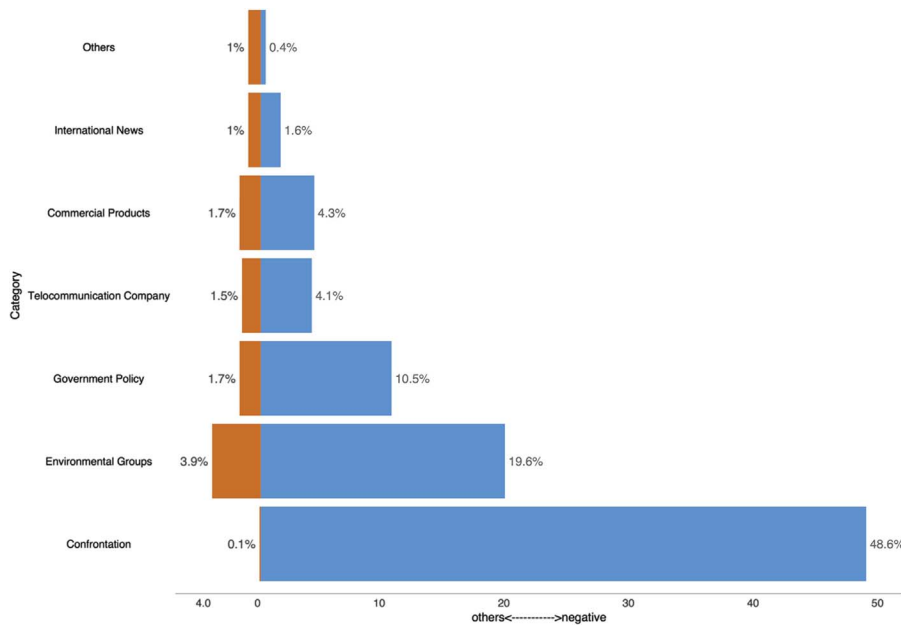


Fig. 5. The direction of the implication conveyed by the contents of newspaper articles, presented in percentage for each category. Negative: the report conveyed detrimental implications of adverse health effects of EMF exposure. Others: the report did not convey the negative implications of the effects of EMF exposure. The chi-square test yielded  $p < 0.0001$ .

media reports and the prevalence of IEI-EMF.

A large part of the articles in the “Government Policy” category dealt with the government’s responses to the public’s actions or concerns, including the decisions to set EMF exposure limits, regulate the locations and the number of base stations, etc. Because the scientific evidence supporting the hazardous effects of EMF on human health is limited, government actions responding to the public fears about EMFs are generally regarded as precautionary measures. However, previous studies found that precautionary measures tended to be considered a cue that a risk might be real and may thus increase perceived risk instead of increasing trust in public health protection (Wiedemann et al., 2006; Wiedemann and Schütz, 2005). In other words, precautionary measures might amplify EMF-related risk perceptions and trigger concerns. Those study results are in line with our finding that the declining trend of the number of articles in the “Government Policy” category was correlated with the declining trend of IEI-EMF prevalence rate, similar to the trend of the number of articles in the “Confrontation” category. In contrast, in an experiment, researchers had the participants read one of three texts and then fill out a questionnaire about their perception of mobile communication and their base station siting preferences: a neutral text, an information booklet about mobile communication, and an emotionally charged newspaper article that reported a conflict about the siting of a new base station (Cousin et al., 2011). They found that participants reading the booklet were able to transfer their knowledge to a base-station-siting task and found locations that would emit less radiation for the phoning population. Therefore, risk communications seem to be more effective than precautionary measures in coping with the public fears about EMFs.

We found that the numbers of mobile phone base stations, mobile phone calling times, and mobile phone users have all been increasing annually in recent years (Fig. 1), indicating that the general population have been exposed to RF-EMF more frequently with higher intensity and longer duration of exposure. However, this contradicts the declining trend in the prevalence of IEI-EMF we observed. In fact, provocation studies generally could not trigger IEI-EMF-related symptoms through exposing the volunteers to RF-EMF (Augner et al., 2012; Nieto-Hernandez et al., 2011; Rubin et al., 2011). These studies aimed at constructing the causality between the exposure to RF-EMF and IEI-EMF symptoms but have not been able to build a link.

The increasing trend in text message service is the only indicator of EMF exposure that might contribute to the decreased IEI-EMF prevalence rate, assuming that sending messages instead of calling using a

mobile phone decreases the intensity (especially to the head) and duration of exposure. However, it is dubious whether this assumption really holds. Furthermore, even if it is true for the exposure from the mobile phone being used by the user, there is still increased environmental exposure to EMF from text message services with the increased number of text messages.

Van den Bergh et al. (2017) hypothesized the development of IEI symptoms has two stages. At Stage 1 sufferers’ symptoms are supposed to result from prior somatic symptom experiences, and at Stage 2 symptoms are linked to the environmental stimuli such as EMF, chemical odors, noise, etc. Once the environmental stimuli and symptoms were bridged, the resulting symptoms would be elicited by the environmental stimuli even in the absence of biological mechanism. Media and activist-provided information would intermedicate the connection between environmental stimuli and symptoms (Witthöft and Rubin, 2013). Dieudonné (2016) proposed a more complicated model describing that sufferers attributing their symptoms to the existence of EMF through a seven-stage process: 1. onset of symptoms, 2. failure to find a solution, 3. discover of EHS, 4. gathering of information about EHS, 5. implicit appearance of conviction, 6. experimentation, and 7. conscious acceptance of conviction. In this model, symptoms come first, and then the sufferers seek for solutions. After the sufferers learning about EHS (IEI-EMF) from the media, friends, internet, etc. (Stage 3), they will begin to gather information (Stage 4), and media coverage plays an important role in attributing their symptoms to EMF exposure by the sufferers. An experimental study randomly assigned the participants to watch a film about the danger of EMF or a control film and found that watching the film was able to increase worries about EMF in the participants (Witthöft et al., 2017). In another experimental study, healthy participants who were assigned to watch a television report on adverse health effects of EMF had increased intensity ratings of tactile (electric) stimuli after exposure to a sham WiFi signal in comparison with those who were assigned to watch a neutral report (Bräscher et al., 2017).

In addition to the effects of media coverage, another potential factor that might contribute to the declined IEI-EMF prevalence in Taiwan is possible adaptation to EMF exposures. In other words, people might build tolerance to EMF exposure physiologically after a certain period of time. In addition, EMF exposure might have some beneficial effects on certain people. A study reported a potential analgesic effect of extreme low frequency EMF exposure that increased the participants’ pain thresholds more than the sham group (Shupak et al., 2004). Furthermore, in an animal experiment using land snail (*Cepaea nemoralis*), after

repetitive exposures to a specific extremely low frequency pulsed EMF, researchers found the snails have a significant increase in the latency time for an aversive reaction to a warmed surface (40 °C) (Thomas et al., 1998). However, the scientific evidence of the existence of such ability is weak, and the decrease in media coverage seems to be a more plausible explanation. Whereas changing diagnostic criteria (definition) would be expected to play a role any reported change in the prevalence of IEI-EMF symptoms, the WHO has not change the definition since it was published in 2005 (WHO, 2005). In addition, the two surveys in Taiwan, one in 2007 and the other in 2012, used the same questionnaire with the same question to inquire the participants for defining IEI-EMF, and therefore the criteria for diagnosing (defining) IEI-EMF have remained constant over the study period and thus unlikely to affect the prevalence.

A major limitation of our study is that we collected information only from newspapers and could not include news coverage from the television, websites, social media, and radio programs because there are no such databases. Nonetheless, these sources of news generally share the same information with newspaper in Taiwan, and therefore the coverage should have the same trend. The “News Knowledge Database” we used in the current study is representative and comprehensive because it covering 10 major newspapers in Taiwan, which cover more than 95% of the newspaper sale in the country. Another major limitation of our study is that the data are on the whole nation, not on individuals. Although the experimental study by Bräscher et al. (2017) demonstrated that the message conveyed by a television report on adverse health effects of EMF may increase the intensity ratings of tactile stimuli after exposure to a sham WiFi signal in health participants, the experiment was not on suffers of IEI-EMF and the response to tactile stimuli may not be the same as the symptoms experienced by IEI-EMF suffers. Therefore, studies with data on individual participants and cover various kinds of mass media are warranted to confirm the findings in our study.

## 5. Conclusions

In conclusion, our study found that from 2005 to 2012, the media coverage of issues related to EMF decreased in Taiwan, and the prevalence of IEI-EMF also decreased. However, other factors contributing to EMF exposure increased during the period, including the density of mobile phone base stations, number of mobile phone users, total mobile phone calling time, and number of text messages sent through mobile phones. These findings indicated a positive association between media coverage and the prevalence of IEI-EMF, which might also be true in other countries.

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