



## Original Article



## Electromagnetic Pollution and Its Health Effects: A Public Awareness and Health Symptom Survey

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## ABSTRACT

In a contemporary world with a lot of electromagnetic fields (EMF) producing appliances, individuals are becoming increasingly worried about the impact that the appliances can have on their health. **Objectives:** To investigate the level of public awareness, behavior, and symptoms of health in relation to non-ionizing electromagnetic radiation of mobile phones, Wi-Fi, and 4G / 5G towers. **Methods:** The study was conducted using a cross-sectional descriptive survey (n=115) with a confirmed questionnaire that was administered online. The Chi-square test and descriptive statistics were used to test the relationships between EMF exposure and reported health symptoms. **Results:** The study revealed that mobile phone addiction is high, and over 60 percent of the respondents spent over six hours a day on the devices. Interestingly, 76 percent of them reported headaches, 66 percent complained of eye strain, and 61 percent complained of sleep problems, which indicates that the long-term exposure to EMF might be associated with neurological symptoms. The chi-square test was used to demonstrate that the association between high EMF exposure and health complaints is statistically significant ( $p < 0.001$ ). **Conclusions:** The paper gives important points on how the community education needs much improvement, policies should be made according to the situation, and more longitudinal studies are needed to understand the health risks of prolonged EMF exposure and mitigate them.

## INTRODUCTION

Electromagnetic pollution (or electromagnetic smog or EMF (electromagnetic field) exposure) is the overabundance in our environment of electromagnetic radiation, mostly man-made (mobile phones, Wi-Fi routers, power lines, and microwave ovens). This paper will examine the awareness, perception, and experiences of the population concerning the exposure to EMF and their possible health impacts [1]. In the world of computers, the level of exposure to electromagnetic fields (EMFs) has become an inevitable part of our lives. As wireless technologies, mobile phones, Wi-Fi routers, power lines and smart meters, and other devices that generate and consume electromagnetic radiation spread, humans are

surrounded by a cloud of electromagnetic radiation that is invisible to the human eye [2]. Though non-ionizing EMFs, including those produced by most domestic and personal devices, are generally deemed to be less harmful than ionizing radiation, increasing public concern and current research indicate that there may be health consequences [3]. The cumulative impact of convergent electromagnetic emissions of several sources is called electromagnetic pollution, or, in other terms, electro-smog [1]. Although no one can deny the industrial and technological advantages of the EMF-emitting devices, the long-term biological effects are not fully comprehended and are the subject of numerous controversies [4, 5]. The symptoms that are



usually associated with EMF exposure are headaches, fatigue, sleeping problems, memory problems, and stress, which can be of different degrees with respect to the duration and exposure proximity [6]. It also aims at determining the level of precautionary measures taken by individuals and the level of interest of people in stricter regulations. The electromagnetic field may be further classified into ionizing EMFs, high-frequency radiation that may cause the break of molecular bonds (e.g., X-rays, ultraviolet rays), and non-ionizing EMFs, which are low-frequency radiation in communication and domestic influence (e.g., radiofrequency radiation of phones, Wi-Fi, and extremely low frequency (ELF) radiation of power lines, etc.) [7, 8]. Although the biological effects of non-ionizing EMFs are currently under study, the well-known biological effects of ionizing radiations are DNA damage and cancer [7, 8]. However, some organizations come out to say that radiofrequency EMFs are possibly carcinogenic to humans, or group 2B (IARC, n.d.), thus drawing new attention and concern [9-12]. In contemporary homes and offices, individuals are constantly exposed to EMF-emitting appliances. They are mobile phones and smartphones, 4G/5G cellular towers, Wi-Fi routers and Bluetooth devices, microwave ovens, smart home appliances, and electrical power lines and substations [13, 14]. This is unlike in the past, where exposure to EMF was restricted to certain industrial or medical settings; today, it is everywhere, continuous, and in many cases long-lasting, especially among the younger age groups and working professionals who spend a lot of time online or close to any electronic gadgets [1]. Anecdotal and clinical evidence is growing, indicating that EMF may play a role in the development of a variety of non-specific symptoms, which include headaches, sleep disturbances, chronic fatigue, eye strain, anxiety or cognitive impairment, dizziness, and memory problems [3, 14]. These symptoms have been generally referred to as Electromagnetic Hypersensitivity (EHS). Nevertheless, it is not a medical diagnosis yet, as inconsistent results have been found and standard biomarkers are lacking [14]. What is certain, despite the debate that has been taking place in the scientific circles, is the increasing national concern and ignorance of EMF pollution and the dangers therein. Especially, this is essential in urbanized and developing areas with high access to digital devices and low awareness of the local population on EMF safety [1, 13]. The existing research is mostly based on EMF exposure in developed nations, and the local or regional data is usually not available. In the regions where digital literacy is increasing and health literacy could be low; people would be unaware of the symptoms associated with EMF or take proper

precautionary steps [2].

The rapid proliferation of EMF-emitting devices such as mobile phones, Wi-Fi routers, and 4G/5G towers has raised public concern regarding potential health impacts, including headaches, eye strain, sleep disturbances, and other neurological symptoms. Despite growing awareness internationally, there is limited local data on public knowledge, behavioral patterns, and self-reported health effects related to EMF exposure, particularly in urbanized regions of developing countries. Additionally, most existing studies focus on developed nations, and evidence from the general population using non-ionizing EMF devices remains sparse. This study aims to investigate public awareness, behavioral patterns, and health-related symptoms associated with EMF exposure, while highlighting the need for improved community education and precautionary practices.

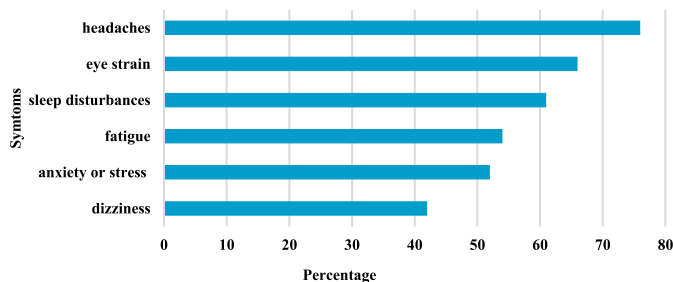
## METHODS

A cross-sectional descriptive survey design was employed, which was suitable for assessing the prevalence of awareness, perceptions, and symptoms at a single point in time. However, this design does not allow for the establishment of causal relationships between EMF exposure and reported health outcomes. The duration of the conducted study was 4-5 months, from January 2025 to May 2025 at Kinnaird College for Women. A questionnaire was designed using Google Forms to be answered by participants. The tool was tested for validity with expert feedback and clarified through pilot testing with a total number of (n=115) individuals to confirm it worked well. Since it consisted of 22 questions, they were divided into different sections. There were single-choice, multiple-response, and Likert-scale questions on the survey. A non-probability convenience sampling method was used because it allowed quick and practical recruitment of participants through online platforms (Facebook, WhatsApp, Instagram, and email). Adults aged 18 years and above who voluntarily participated. Individuals below 18 years and incomplete or duplicate responses. A validated Google Forms questionnaire with 22 items (single-choice, multiple-response, and Likert-scale) was used. The research was conducted between April 2025- May 2025, and 150 original responses were obtained. Following the completeness and duplicate screening, the final analysis comprised 115 valid responses. This sample size (n=115) is believed to be sufficient to conduct a preliminary cross-sectional survey, and it would be satisfactory to explore health surveys where a sample size of 100 is usually recommended to produce stable estimates to describe and draw basic inferences. Inclusion criteria included adults aged 18 years and above who were capable of accessing and filling out the online questionnaire. This was done by

excluding those under the age of 18, incomplete, or duplicate responses. No medical exclusion criteria were implemented because the study was done to survey the general adult population. It is necessary to mention that since the recruitment process was made with the use of online sources (Facebook, WhatsApp, Instagram, email) only, the sample will most probably be biased, as the sample of all adults will not be fully represented by the sample of people with greater internet consumption. Google Forms was used to design a questionnaire. The validity of the tool was tested by the expertise of the researcher, and its comprehensibility was tested by a pilot test using another sample (n=15). The Likert-scale items that were used in the quantitative analysis were evaluated on internal consistency reliability, and Cronbach's alpha was calculated, which gave a satisfactory value of 0.78, which is good reliability. The data were cleaned and coded using Microsoft Excel. The descriptive statistics (frequencies and percentages) were conducted in Python, whereas the inferential statistics (Chi-square test) were conducted in SPSS (version 27.0) to check the relationship between EMF exposure and health symptoms. The Cramer V was used to determine the strength of association.

## RESULTS

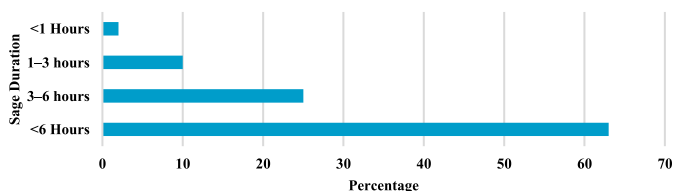
Out of the 150 responses obtained, 115 valid responses were analyzed, and this gave a mean age of 22.4 years (SD = 2.1). EMF exposure patterns, awareness, and health-related symptoms were summarized using descriptive and inferential statistics. 87 (76%, 95% CI: 68.2% to 83.8%) had headaches, 76 (66%, 95% CI: 57.7% to 74.3%) experienced eye strain, and 70 (61%, 95% CI: 52.3% to 69.7%) had sleep disturbances. Fatigue 62 (54%), anxiety or stress 60 (52%), and dizziness 48 (42%) were other characteristics frequently used. The Chi-square test demonstrated that the frequency of EMF exposure was statistically significantly associated with the prevalence of health symptoms ( $\chi^2 = 24.36$ ,  $df = 6$ ,  $p < 0.001$ ). This relationship had a moderate effect size with the Cramer V of 0.46. The Cramer V of 0.46 was a moderate relationship between high EMF exposure and the symptoms reported (Figure 1).



**Figure 1:** Reported Health Symptoms After EMF Exposure

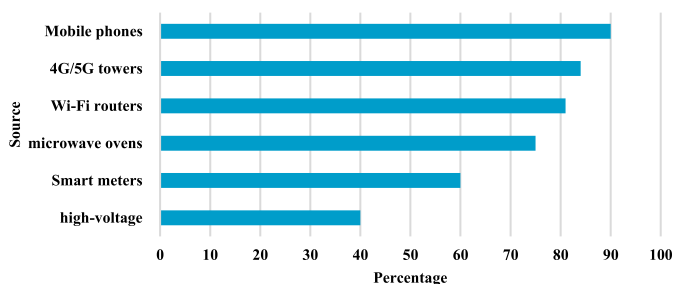
Most participants, 72 (63%), reported using mobile phones for more than six hours per day, while 29 (25%) used them

for 3–6 hours, 11 (10%) for 1–3 hours, and only 3 (2%) for less than one hour daily (Figure 2).



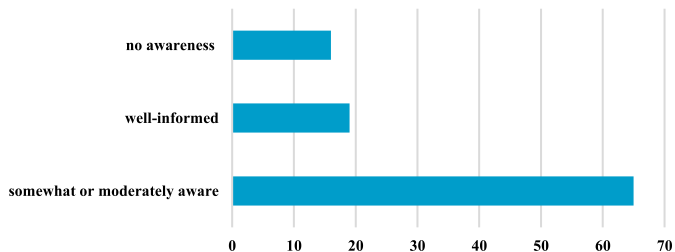
**Figure 2:** Daily Mobile Phone Usage among the Population

Mobile phones were identified as the main source of EMF pollution by 104 (90%) of respondents, followed by 4G/5G towers 97 (84%), Wi-Fi routers 93 (81%), and microwave ovens 86 (75%). Smart meters and high-voltage powerlines were mentioned by 69 (60%) and 46 (40%), respectively (Figure 3).



**Figure 3:** Perceived Sources of EMF Pollution

Overall, 75 (65%) of participants were somewhat or moderately aware, 22 (19%) were well-informed, and 18 (16%) reported no awareness regarding EMF exposure and its health effects (Figure 4).



**Figure 4:** Knowledge of EMF Exposure and Its Health Effects

## DISCUSSION

The objective of this study was to determine the awareness, behavior, and health issues regarding exposure to electromagnetic fields (EMF). The findings offer valuable information as to the interaction of different demographic and behavioral variables, especially the level of education, the time spent on phones, and precautionary practices, with the perceptions of the population and self-reported health outcomes. The findings showed that an increasing concern about EMF exposure in society is on the rise in line with the international reports by the World Health Organization [9]. These statistics indicated that high levels of EMF were measured daily, and most of them were on mobile phones and Wi-Fi routers. Moreover, a more

educated population was more familiar with the subject of electromagnetic pollution, and it has been shown in the past that the level of awareness tends to increase with the level of education and access to scientific information [15, 16]. It is noteworthy that the higher level of awareness and the number of hours spent using the mobile phone (more than six hours per day) had a strong association with the self-reported headaches, fatigue, and sleep disturbances. Past biological and epidemiological studies have identified such similarities between protracted exposure to EMF and neurological symptoms [13]. Although the non-ionizing radiation is not so powerful that it may lead to direct damage to DNA, it was demonstrated that such oxidative stress and DNA strand breaks may be present in the case of long-term exposure [3, 7]. Although the participants were aware of the risks to their health, a large part still did not take precautions regularly, which suggests the differences between the knowledge level and the protective measures. The rising levels of international advocacy of the use of biologically based exposure limits can be seen as the product of increasing numbers of countries driving towards more restrictive regulatory policies and independent research on the health effects of EMF [17, 18]. Besides, the statistically significant association identified by using the chi-square test was supported by a moderate effect size (Cramers  $V = 0.46$ ). It demonstrates that there is a significant correlation between exposure to EMF and health-related complaints, which proves earlier assumptions that the EMFs may have an influence on the well-being, even at non-ionizing proximities [19, 20]. These findings are accompanied by testimonies that describe the symptoms that belong to electromagnetic hypersensitivity [14]. But some constraints have to be admitted.

Another bias that was applied to the sample was that of highly learned individuals, which may not be the representative population. The reporting of symptoms was not clinically verified and existed as self-report; this can have introduced a bias in it. Moreover, as it is a cross-sectional study, the causal relations between the exposures of EMF and the health outcomes cannot be discussed. The future research should therefore follow longitudinal or experimental methods and objective biological measures to assist in shedding some light on the mechanisms of the latter laboratory research.

## CONCLUSIONS

The paper provides valuable statements about the way in which community education should be significantly improved, policies must be adjusted in line with the circumstances, and additional longitudinal investigations should be carried out to comprehend the health hazards of sustained exposure to EMF and how they can be avoided.

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## Authors' Contribution

Conceptualization: NR  
 Methodology: NR, MS, AR  
 Formal analysis: NR, MS, AR  
 Writing and Drafting: NR, MS, AR  
 Review and Editing: NR, MS, AR

All authors approved the final manuscript and take responsibility for the integrity of the work.

## Conflicts of Interest

The authors declare no conflict of interest.

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