

# Mobile Cellular Data and Wi-Fi Use Are Not Associated with Adverse Health Effects

Marziye Rabiei (MSc)<sup>1</sup>, Seyed Jalil Masoumi (MD, PhD)<sup>2,3,4</sup>, Seyed Mohammad Javad Mortazavi (PhD)<sup>5,6</sup>, Samane Nematolahi (PhD)<sup>7</sup>, Masoud Haghani (PhD)<sup>8\*</sup>

## ABSTRACT

**Background:** Smartphone users frequently connect to the Internet via mobile data or Wi-Fi. Over the past two decades, the worldwide percentage of people who connect to the Internet using their mobile phones has increased drastically.

**Objective:** This study aimed to evaluate the potential link between mobile cellular data/ and Wi-Fi use and adverse health effects.

**Material and Methods:** This cross-sectional study was conducted on 2,796 employees (52% female and 48% male) of Shiraz University of Medical Sciences (SUMS), Shiraz, Iran. The sociodemographic data (e.g., gender, age, nationality, and education level) were collected for all the participants. They were also requested to provide information about their smartphone use including the characteristics of the connection to the Internet using their smartphones (mobile data and Wi-Fi). In addition, the participants' history of diabetes, hypertension, cardiac ischemia, myocardial infarction, renal failure, fatty liver, hepatitis, chronic lung disease, thyroid disease, kidney stone, gall bladder stone, rheumatoid disease, epilepsy, and chronic headache was recorded through face-to-face interviews.

**Results:** 94% of people participating in this study reported using mobile/Wi-Fi internet. The mean ( $\pm$ SD) Internet usage per day was  $117.85 \pm 122.70$  minutes including  $76 \pm 98$  minutes of mobile data and  $42 \pm 81$  minutes of Wi-Fi use.

**Conclusion:** Our findings showed no link between mobile phone Internet usage and the risk of the above-mentioned health problems. As in 2021, the global average daily time spent on the Internet using mobile phones was 155 minutes, the participants' lower use time could explain the failure to show any detrimental effects. Considering the study limitations, further large-scale studies are warranted.

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## Keywords

Smartphone; Internet; Cellular Data; Wi-Fi; Health

## Introduction

Wireless communication has grown exponentially in the world over the past decades. Recently, the fourth-generation (4G) and the fifth-generation (5G) of mobile network technology have revolutionized our communications. In actual scenarios, neither 4G nor 5G has been fully assessed for their safety [1, 2]. So, the public seems to be concerned about the potential health effects of exposure to Radiofrequency Electromagnetic Fields (RF-EMF). For Wi-Fi modem routers, this concern has been intensified because routers are usually

<sup>1</sup>Student Research Committee, Department of Medical Physics and Engineering, School of Medicine, Shiraz University of Medical Science, Shiraz, Iran

<sup>2</sup>Nutrition Research Center, School of Nutrition and Food Sciences, Shiraz University of Medical Science, Shiraz, Iran

<sup>3</sup>Gastroenterohepatology Research Center, Shiraz University of Medical Sciences, Shiraz, Iran

<sup>4</sup>Center for Cohort Study of SUMS Employees' Health, Shiraz University of Medical Science, Shiraz, Iran

<sup>5</sup>Ionizing and Non-Ionizing Radiation Protection Research Center (INIRPRC), School of Paramedical Sciences, Shiraz University of Medical Sciences, Shiraz, Iran

<sup>6</sup>Department of Medical Physics and Engineering, School of Medicine, Shiraz University of Medical Science, Shiraz, Iran

<sup>7</sup>Noncommunicable Diseases Research Center, Bam University of Medical Sciences, Bam, Iran

<sup>8</sup>Department of Radiology, School of Paramedical Sciences, Shiraz University of Medical Sciences, Shiraz, Iran

\*Corresponding author: Masoud Haghani  
Department of Radiology, School of Paramedical Sciences, Shiraz University of Medical Sciences, Shiraz, Iran  
E-mail: haghanimasoud2@gmail.com

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placed inside our houses [3, 4].

Humans are continuously exposed to non-ionizing radiation from different sources. Mobile phones and wireless systems are the leading sources in potential harmful effects of non-ionizing radiation [5]. Wi-Fi systems use radiofrequency (RF) transceivers to support Wireless Local Area Networks (WLANs) [6]. The majority of Wi-Fi devices work within 2.400-2.4835 GHz of the electromagnetic spectrum. Over the past years, some studies have addressed the health effects effects of 2.45 GHz Wi-Fi radiation [7, 8]. Ishak NH et al. proposed that the biological system might be influenced by electromagnetic radiation [9].

Over the last few years, many scientists have evaluated the health effects of electromagnetic radiation. Some studies indicated that biological effects were related to oxidative stress due to the augmentation of Reactive Oxygen Species (ROS) [10-12]. Furthermore, Wertheimer and Leeper emphasized that excessive exposure to EMFs from power lines was associated with an increased risk of cancer, since they detected an increase in the incidence of childhood cancer among the children whose homes were near power lines [13]. Overall, the harmful effects of exposure to Wi-Fi-induced radiation included decreased fertility in men, oxidative stress, cellular DNA damage, and hormonal changes [14].

Smartphone owners frequently connect to the Internet via mobile data or Wi-Fi to look up information, access emails, share pictures and videos, do online shopping or banking transactions, find directions, take part in online classes or training programs, and obtain health information [15]. The global proportion of the people who connect to the Internet has been increased from 6.5% in 2000 to 43% in 2015 (700% growth) [16, 17]. As of April 2022, this proportion was globally increased to five billion internet users (63.1 percent of the world population). Considering the importance of the effects of Internet use on human health, the present study aims to assess the re-

lationship between utilizing Wi-Fi and mobile data and the risk of adverse health effects.

## Material and Methods

This cross-sectional study was performed on 2,796 employees (52% female and 48% male) at Shiraz University of Medical Sciences (SUMS). The participants' sociodemographic data (e.g., gender, age, nationality, and education level) were collected. They were also requested to provide information about their smartphone use including the pattern of connection to the Internet (mobile data and Wi-Fi). Moreover, the history of diabetes, hypertension, cardiac ischemia, Myocardial Infarction (MI), renal failure, fatty liver, hepatitis, chronic lung disease, thyroid disease, kidney stone, gall bladder stone, rheumatoid disease, epilepsy, and chronic headache was recorded through face-to-face interviews.

## Statistical Analysis

All analyses were performed using the SPSS version 22 (SPSS Inc., Chicago, IL, USA). Different statistical tests were used to investigate the relationship between the mobile/Wi-Fi internet use and the adverse health effects. A *P*-value of <0.05 was considered statistically significant.

## Ethical Considerations

The present study was approved by the ethics committee of Shiraz University of Medical. Data collection procedures were approved by the Vice Chancellery for Research, Shiraz University of Medical Sciences.

## Results

This study was conducted on 2,796 SUMS employees (52% female and 48% male). The participants' demographic information has been summarized in Table 1. Accordingly, the participants aged 20-70 years, with the mean age of 42.5 years (SD=6.99). Additionally, 1.6% of the participants were illiterate, 0.1% had only finished primary school, 4.2% had

junior high school degrees, 4.5% had high school diplomas, 18% had associate degrees, 11.3% had bachelor’s degrees, 42.3% had master’s degrees, 18% had PhD degrees.

The results indicated that approximately 94% of the participants used the Internet. Among participants, although the internet use was more frequent in females (95%) than in males (93%), this difference was not statistically significant ( $P=0.075$ ). The overall mean

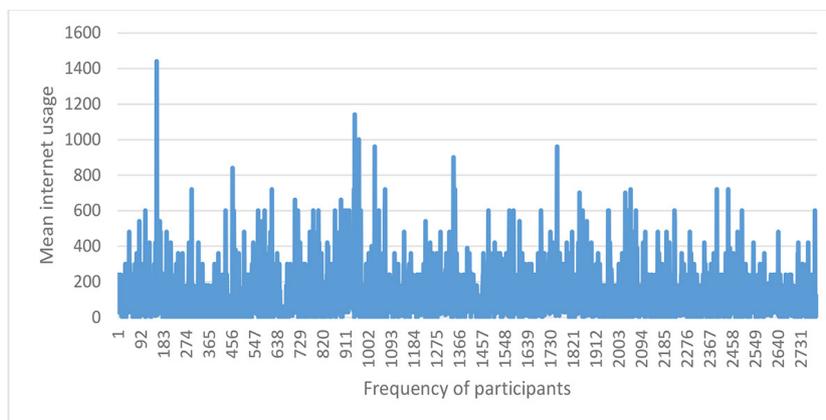
( $\pm$ SD) Internet usage was  $118.93\pm127.78$  min per day. The distribution of Internet use duration among the participants is shown in Figure 1. Accordingly, the majority of the participants used more mobile data compared to Wi-Fi to connect to the Internet. The time spent on the Internet through mobile data and Wi-Fi was  $76.0\pm98.74$  and  $42.89\pm81.18$  minutes per day, respectively. However, again this difference was not statistically significant. The average daily online time (minutes) in our participants is compared to the global average usage in 2011 and 2021 in Figure 2.

**Table 1:** Demographic characteristics of participants

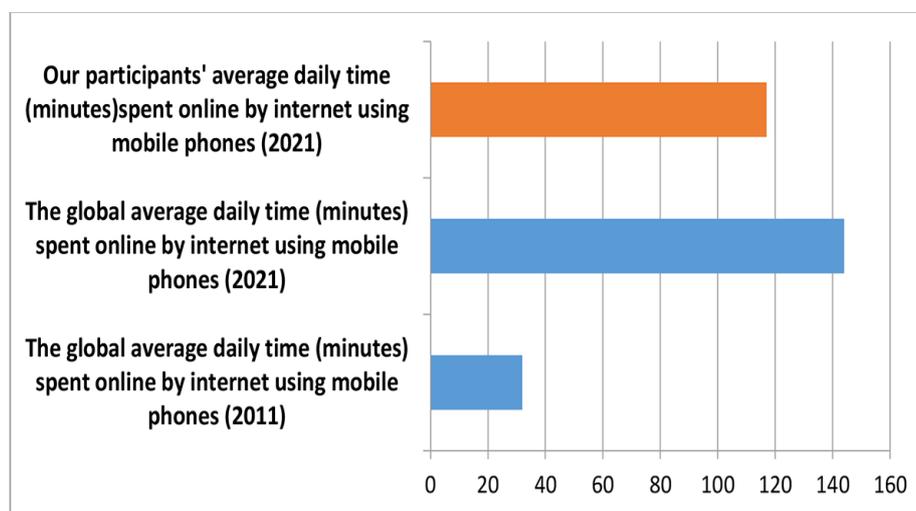
Characteristics	Mean $\pm$ SD
<b>Age (years)</b>	42.54 $\pm$ 6.99
<b>Gender</b>	<b>Frequency (%)</b>
Male	1287 (45.9%)
Female	1514 (54.1%)
<b>Education level</b>	<b>Frequency (%)</b>
Illiterate	46 (1.6%)
Primary school	4 (0.1%)
Some high school	117 (4.2%)
High School Diploma	127 (4.5%)
Associate degree	502 (18%)
Bachelor’s degree	315 (11.3%)
Master’s degree	1182 (42.3%)
PhD	503 (18%)

### Discussion

To the best of our knowledge, this study is the first large-scale investigation on the adverse health effects of mobile cellular data and Wi-Fi RF-EMF use alone (when calls are excluded). According to an old belief, the detrimental biological effects of RF-EMF are mostly linked to thermal effects. Considering this belief, exposure to RF-EMF is mainly linked to eyes and testicular damage, tissues having relatively a limited circulation. Increased core body temperature due to radiofrequency radiation absorption can lead to fatigue and lethargy [14]. Fatigue can decrease mental performance, and cause cardiovascular problems, and hypertension. Particularly, exposure to high-intensity RF-EMF can be associated with the lack of



**Figure 1:** Distribution of internet use duration among the participants



**Figure 2:** Comparison of our participants' average daily time (minutes) spent online by internet using mobile phones (2021) with the global averages in 2011 and 2021

adequate circulation, oxygenation, and waste disposal due to [18, 19]. However, the present study findings highlight the key importance of the studies on non-thermal effects of RF-EMF. Our study showed that mobile cellular data and Wi-Fi use is not associated with any known health effects. We believe that this issue may be associated with the low average mobile internet use in our participants compared to the worldwide levels. The global average mobile internet use has increased from 32 min/day in 2011 to 155 min/day in 2021, while in our participants it was  $118.93 \pm 127.78$  min/day. The low average mobile Internet use along with a wide spectrum of other factors can be involved in the failure of our study to show any detrimental effect. Our findings regarding Wi-Fi, are in line with the results of the study conducted by Foster et al. in 2013 who claimed that Wi-Fi has no detrimental health effects [20]. However, on a broader scale, when any source of RF-EMF (not only Wi-Fi) is taken into account, our findings do not confirm those studies that showed long-term exposure to RF-EMF could increase the risk of adverse health effects such as cancers and other diseases [18, 19, 21]. However, the

results of other studies are contradictory [22, 23]. Considering the limitations of our study, further large-scale studies are warranted.

## Conclusion

This study showed that mobile Internet use was not associated with adverse health effects. Considering the limitations of our study, further large-scale studies can shed more light on the safety issues of mobile Internet use.

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## Authors' Contribution

SMJ, Mortazavi, SJ, Masoumi, and M. Haghani contributed to the study conception and design. Material preparation, data collection, and analysis were performed by SMJ, Mortazavi, M. Rabiei, SJ, Masoumi, M. Haghani and S. Nematollahi. The first draft of the manuscript was written by SMJ.

Mortazavi, M. Rabiei, M. Haghani. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

### Ethical Approval

This study was approved by the ethics committee of Shiraz University of Medical Sciences with the code of ethics (IR.SUMS.REC.1400.332).

### Informed consent

Informed consent was obtained from all participants.

### Conflict of Interest

SMJ. Mortazavi, as the Editorial Board Member, was not involved in the peer-review and decision-making processes for this manuscript.

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