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5G Radiofrequency Radiation Caused the Microwave Syndrome in a Family Living Close to the Base Stations

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Abstract

The fifth generation, 5G, for wireless communication has been implemented in various countries since 2019. The deployment in Sweden started in 2020 where the used frequencies for 5G in cities are around 3.5 GHz. Recently, we published three case reports on persons that developed the microwave syndrome within short after the installation of 5G base stations close to their dwellings. The health symptoms were attributed to high levels of radiofrequency (RF) radiation measured in their apartments. In this article we examine a family of three persons living at distances of about 50 and 70 meters to two 5G base stations. The base stations are located on the top of two 6-floor buildings and the antennas are directed towards the family's apartment on the 4th floor on the opposite side of the street. Measurements in the apartment were made 10 times at every place, each measurement during 1 minute. Highest levels were measured close to the two windows in the master bed room varying from 320 000 to 1 200 000 µW/m^2. High levels were also found at the window of the son's room, 121 000 to 490 000 µW/m^2, and the daughter's room 34 800 to 166 000 µW/m^2. Somewhat lower levels were found in the beds at the place of the pillow for all family members. Lowest levels were measured in the kitchen on the opposite side of the apartment, 710 to 3 260 µW/m^2. Health problems were assessed by using a structured questionnaire similar to our previous studies. The family members reported symptoms included in the microwave syndrome to varying self-estimated degrees. The daughter had the most severe health issues, for example sleeping problems, headache, concentration and memory problems, skin disorders, irregular heartbeat, light sensitivity, anxiety and panic attacks

These results are in line with previous case studies showing that deployment of 5G cannot be made without risks to human health, especially for those living or working in the proximity of the base stations.

Keywords: Base Station; 5G; Radiofrequency radiation; Electromagnetic hypersensitivity; Microwave syndrome; Health

Introduction

The Fifth Generation, 5G, for wireless communication has been deployed since 2019 (https://www.verizon.com/about/our-company/5g/when-was-5g-introduced) although without any research since before on possible detrimental effects on human health or the environment, or any studies indicating that 5G would not be harmful. However, there was already strong concern among many scientists and physicians that the increase in pulse-modulated radiofrequency (RF) or microwave radiation from 5G would

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cause serious health consequences, expressed for instance in the 5G Appeal to EU since 2017 (https://www.5gappeal.eu/). Microwaves are frequencies between 300 MHz and 300 GHz within the RF frequency spectrum and it is within that frequency range that 5G operates. In Sweden in city environments, the frequencies used for 5G base stations are within the 3.5 GHz band (https://pts.se/sv/5g/inforande-av-5g/). 5G initially functions in combination with 4G. Thus 5G antennas are installed together with 4G antennas and therefore people living in close proximity to 5G base stations are exposed to a combination of 4G and 5G (https://www.forbes.com/sites/bobodonnell/2019/11/06/the-4g-5g-connection/?sh=66c997231a00). Up until the beginning of 2023 there was still no research performed on health effects of exposure to neither real 5G radiation nor 5G combined with 4G, to our knowledge.

The ICNIRP thermal limits

The limits for allowed exposure to RF or microwave radiation applied by most countries around the world, recommended by the WHO and the European Commission for instance, are still based only on heating (thermal) effects that appear within a very short time of exposure. Protection against long-term exposure and any other harmful effects that are not based on heating (non-thermal) are thereby excluded [1-4]. The guidelines based on heating are set by the International Commission on Non-Ionizing Radiation (ICNIRP), an organization based in Germany, or by the Federal Communications Commission (FCC) in the USA [3, 4]. Although ICNIRP has been heavily criticized for having ties to the telecommunications industry [5] and for recommending limits that are insufficient for protection against known harmful effects, ICNIRP has obtained world-wide major influence. The ICNIRP guidelines are based on evaluations that have rejected all scientific evidence on effects that are not caused by heating, despite growing evidence of a range of harmful non-thermal effects well below their recommended maximum levels.

The ICNIRP guidelines are important to the telecommunications industry, thereby facilitating the deployment of 5G and the wireless society [6, 7].

The history of the microwave syndrome

The microwave syndrome, microwave sickness or illness as an effect of exposure to non-thermal levels of microwave radiation, was reported already in the 1960's and 1970's in the East European countries [8, 9]. Another term for the illness is radiofrequency sickness syndrome [10]. In studies of workers exposed to RF radiation, the researchers reported that the nervous system was most commonly affected together with the cardiovascular and endocrine systems. Chronically exposed workers complained of symptoms such as fatigue, dizziness, headache, sleep disorders, anxiety, problems with attention and memory, pain in the heart region, in the muscles and breathing difficulties. Women were observed to be generally more sensitive to the exposure than men [11]. In a review of early studies it was stated already in 1969 that "A surprisingly wide variety of neurological and physiological reactions are to be expected" [12].

The effects of the exposure depend not only on the carrier frequency, for instance 3.5 GHz as for 5G, but also, and perhaps more importantly so, on the modulation and/or pulsation of the signal and as well as on the peak and average intensity. Pulsed signals and simultaneous exposure to several frequencies has been observed to cause more effects and were thus considered more hazardous. The observed effects increased with time of exposure [13, 14].

It was also observed, that in general, the symptoms declined once the exposure had ended. According to Marha et al "at a certain time after exposure had ended (sometimes as long as several weeks or more) (see page 31), the organism usually returns to its original physiological state and all subjective and objective complaints vanish" [11]. In conclusion, in view of early studies, it is to be expected that 5G microwave exposure, combined with exposure to 4G, may cause symptoms consistent with the microwave syndrome. It also follows that it is important to investigate exposure to real 5G and 4G signals in combination as in real life exposure.

Previous studies on 5G or 3.5 GHz

Studies on possible health effects from exposure to the 5G frequencies used in Sweden around 3.5 GHz were until recently more or less non-existent [15]. A study published in 2020 exposed zebrafish embryos to RFR 3.5 GHz to 22 μW/m^2 (at the water surface) with SAR calculated to very high 8.27 W/kg, for 42 hours [16]. However the exposure lacks the characteristics of real mobile phone technology radiation exposure, such as modulation and pulsation that have been reported to be crucial [17]. According to the authors there were no significant impacts on mortality, morphology or photomotor responses, but they observed a "modest depression of sensorimotor function" which may lead to later life effects as "adult neuropsychiatric outcomes, like those detected in previous RFR [Radiofrequency Radiation] studies".

In a study published in October 2022, rats were exposed to 3.5 GHz that was GSM modulated, for 2 hours a day to 1 600 000 μW/m^2, 5 days a week for 30 days. The exposure caused oxidative stress and an increase of degenerated neurons in the hippocampus region of the brain in addition to increased Irisin levels. The observed effects may increase the risk of neurodegenerative diseases after continued exposure [18]. The level of exposure was well below the guidelines recommended by ICNIRP [3].

In addition the same research group published another

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study in April 2023, with the same exposure conditions (rats exposed to 3.5 GHz 2 hours/day, 5 days/week to 1 600 000 μW/m^2 during 30 days) with the objective to study effects on bone mechanics and oxidative stress parameters in muscle tissue. The exposure negatively impacted bone strength and caused oxidative stress in muscle tissue. The latter effect was more pronounced in diabetic rats [19].

Further, Moussa in 2009 exposed rats to 3.5 GHz unmodulated signal with a calculated SAR of 1 W/kg, well below the ICNIRP SAR value of 2 W/kg. The exposure duration was up to two months. The exposure caused oxidative stress in the liver, kidneys and the plasma and increased the electrical conductivity of haemoglobin [20]. None of these studies used 5G signals corresponding to the exposure that people are exposed to in real life from 5G base stations. However the ones that are most similar to real life exposure are those that used GSM modulation [18, 19]. During the first quarter of 2023, we published three case studies on health effects from exposure to RF radiation from 5G base stations [21-23]. All three studies showed that the study persons rather rapidly developed symptoms known as the microwave syndrome or microwave illness after the installation of 5G base stations close to their apartments or office. Spot measurements showed that the deployment of 5G caused very high peak levels of microwave radiation in the study person's dwellings.The first study investigated effects of a 5G base station installed on the roof right above the apartment where a man aged 63 years and a woman aged 62 years lived since several years. After the 5G deployment both quickly developed symptoms compatible with the microwave syndrome [21]. Very high peak RF radiation with highest measured peak value >2 500 000 μW/m^2 was measured in the bedroom located only 5 meters below the new 5G antennas. Since that is the upper detection limit for the used meter, the real peak levels are most likely even higher. Prior to 5G, a peak level of 9 000 μW/m^2 was measured in the bedroom from the 3G/4G base station that had been active at the same spot since several years. Because of the severity of their symptoms, the couple left the apartment within a couple of days for another dwelling with much lower maximum RF radiation with the peak level measured to 3 500 μW/m^2. The man's and the woman's symptoms declined within few days. This is an example of a provocation test.

In our second study, two men aged 57 and 42 years respectively, were studied after a 5G base station was installed on the roof of the building where they worked. The men's office was located at the top floor [22]. After the deployment of 5G high peak RF radiation levels were measured in the office, with highest peak level of 1 180 000 μW/m^2 in the office room right below the antennas. Both men also developed symptoms of the microwave syndrome within a short time period.

After leaving the office permanently, the symptoms disappeared. As in the first study, a base station for 3G/4G was already at the same spot since several years prior to the replacement by 5G technology. This was another clear example of a provocation test with the persons being their own control subjects.

Our third case study described a woman aged 52 years who also developed symptoms of the microwave syndrome within days of the deployment of a 5G base station at 60 meters distance [23]. The 5G antennas were directed at her apartment. Very high peak RF radiation levels, >2 500 000 μW/m^2, were measured on the balcony in front of the base station (highest detection limit for the used exposimeter). In the living room maximum peak levels varied between 222 000 and 758 000 μW/m^2. The symptoms declined rapidly when the woman left the apartment for another dwelling with considerably lower microwave peak radiation levels.

These three case studies are to our knowledge the first studies so far made on health effects in persons exposed to real life 5G microwave radiation. Since the research on health effects from exposure to 5G is extremely scarce, we were motivated to do further investigations of health effects from real exposure to RF radiation from 5G.

This case study

In this article we present a new case study of a family including three persons, a woman 55 years, a 20 year old man and a 19 year old woman. The fourth family member, the father, did not participate. All live in an apartment with two 5G/4G base stations directed towards their apartment, one at a distance of around 50 meters and the second at a distance of around 70 meters. The base stations are placed on the roof of two adjacent 6-floor buildings. The apartment of the family is located at a slightly lower height, on the fourth floor, in another building across the street (Figure 1).

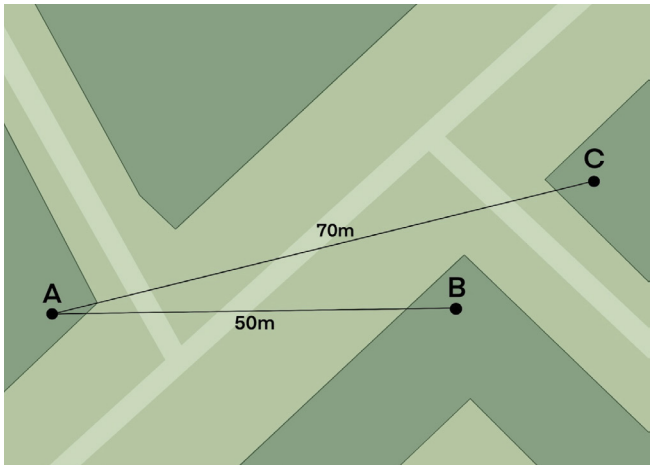

Figure 1: Studied apartment (A) situated at 50 meters from a 5G base station; (B) and 70 meters from a 5G base station; (C) on the opposite side of the street.

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Base stations for 3G and 4G had previously been active at the same locations since at least 2013, but were replaced by 5G and 4G technology and antennas in the middle of July 2021 (B in Figure 1) and during the month of May 2022 (C in Figure 1).

Methods

On March 20, 2023, the two of us visited the family and the apartment of this study. The family members had previously been asked to document eventual symptoms experienced since the time of the deployment of the 5G base stations. The questionnaire was also used in our previous case studies. In this case study only symptoms experienced after the deployment of the 5G base station were investigated. The measurements were made during daytime with the device Safe and Sound Pro II. The true response detection range is between 400 MHz and 7.2 GHz. It was calibrated by the manufacturer and has an accuracy of ±6 dB (https://safelivingtechnologies.com/products/safe-and-sound-pro-ii-rf-meter.html). The frequencies used for 5G in city environments in Sweden are mostly around 3.5 GHz. The upper detection limit for peak values of the used exposimeter is 2 500 000 μW/m^2. At every investigated place in the apartment 10 measurements were made and the peak value during 1 minute was documented.

Results

Health symptoms

The results of self-assessed experienced symptoms by March 20, 2023 are presented in Table 1. Among the family members the youngest woman, aged 19, reported severe sleeping problems, diarrhoea, skin problems, concentration difficulties, headache, irregular heartbeat, light sensitivity, anxiety and panic attacks, which she estimates to be between 8 to 10 on the 10-grade severity scale. The young man, aged 20, estimated his most severe symptoms to be nosebleeds, concentration and memory problems, ear heat/otalgia and joint pain followed by hair loss, confusion, vision problems and waking up in the middle of the night, estimated to be between 4 and 5 on the 10-grade scale. The woman, aged 55, declared fewer symptoms that were less severe. Most severe (grade 5) was concentration difficulties and tiredness followed by vision problems (grade 4), memory problems and waking up at night (grade 3).

Measurement of RF radiation

In table 2 the results of the measurements of RF microwave radiation are presented. The highest levels were found in the room of the apartment situated closest to the 5G base stations which is the master bed room of the woman aged 55, and her husband (did not participate). The room is situated on the corner of the building and has two windows facing the two 5G base stations (Figure 1). Between 342 000 and 1 200 000 μW/m^2 were measured close to one of the two

Table 1: Clinical symptoms grades 0-10. Grade 0 = no symptoms, 10 = unbearable pain and/or discomfort. Date of assessment March 20, 2023.

Symptom	Woman aged 55	Man aged 20	Woman aged 19
Headache	0	0	8
Dysesthesia	1	3	0
Myalgia	2	3	5
Arthralgia	0	5	0
Ear heat/Otalgia	0	5	2
Tinnitus	0	0	2
Hyperacousis	0	0	1
Dizziness	3	0	1
Balance disorder	0	0	2
Concentration/Attention deficiency	5	5	9
Loss of short-term memory	3	5	3
Confusion	0	4	0
Fatigue	5	3	6
Sleeping difficulty			
- insomnia	0	3	10
- waking night time	3	4	10
- early morning wake up	2	0	3
Depression tendency	1	0	4
Suicidal ideation	0	0	0
Cardiovascular abnormalities	0	0	1
- transitory high pulse	0	0	0
- irregular pulse	0	0	8
- slow pulse	0	0	0
Ocular deficiency	3	4	3
Photosensitivity	0	0	8
Anxiety/Panic	0	3	8
Emotive	0	0	3
Irritability	1	3	7
Global body dysthermia	0	0	6
Dyspnoea	0	0	0
Chest squeeze	0	0	3
Cough	0	0	0
Diarrehea (involuntary)	0	0	9
Urinary system – urgency	1	0	0
Skin (face, arms, legs)	0	0	9
Burning, lancinating skin on hands and arms	0	3	2
Nose bleeding	0	5	3
Blood pressure (high or low)	0	0	0
Hair loss	0	3	0

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Table 2: Measurement of RF radiation in an apartment on March 20, 2023. Results are given in µW/m². Ten measurements were made at every place, each during one minute. Lowest and highest levels are given.

Location	Max (peak)
Kitchen, table	710 to 3 260
Dining room	50 400 to 121 000
Living room	45 100 to 98 400
Bedroom, master	
-window 1	342 000 to 1 200 000
-window 2	320 000 to 1 120 000
-pillow, mother	160 000 to 374 000
Bedroom, son	
-window	121 000 to 490 000
-pillow	15 600 to 89 600
Bedroom, daughter	
-window	34 800 to 166 000
-pillow	30 500 to 58 500
Entrance, street	45 900 to 366 000

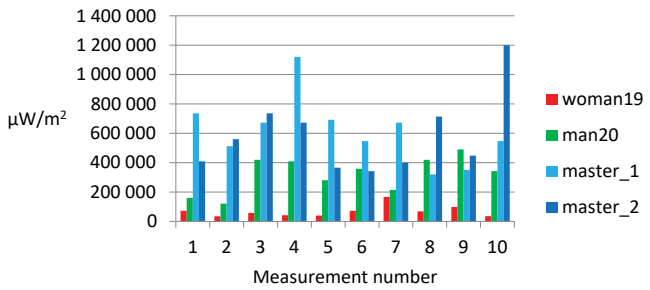

Figure 2: Measurements of RF radiation by the windows in the three bedrooms in the apartment, the master bedroom (window master_1 and master_2) and the bedrooms of the two young people.

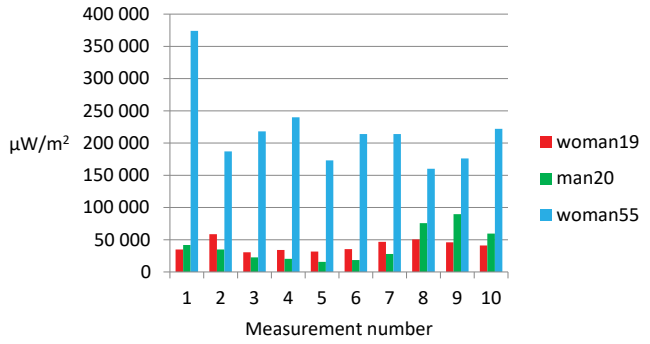

Figure 3: Measurements of RF radiation at the pillow where the three study persons sleep.

windows and between 320 000 and 1 120 000 µW/m² near the second window (Figure 2). At the pillow in the bed where the woman sleeps, peak levels varied between 160 000 to 374 000 µW/m² (Figure 3). In the bedroom of the young man, which is situated on the side of the apartment facing the both 5G base stations but at a longer distance than the master bedroom, levels near the window were between 121 000 to 490 000 µW/m². On the pillow the peak levels were found to be lower, between 15 600 and 89 600 µW/m².

In the bedroom of the young woman, which is also on the side of the apartment facing the base stations but at somewhat further distance to the two base stations compared to the young man, levels of RF radiation were slightly lower.

At the window levels varied between 34 800 and 166 000 µW/m² and on the pillow the levels varied between 30 500 and 58 500 µW/m². In the dining room and the living room which are situated between the master bedroom and the young man's bedroom, facing the two 5G base stations, maximum peak levels of 98 400 and 121 000 µW/m² were measured at the sofa in the living room, and at the dinner table, respectively.

Lower RF radiation was measured in the kitchen situated on the opposite side of the apartment facing a courtyard with no visible base stations. Maximum peak levels were between 710 and 3 260 µW/m².

Discussions

In this article we present a case study of a family including the mother and two young people (son and daughter) living in an apartment facing two 5G base statons that are situated on the other side of the street at a distance of 50 and 70 meters, respectively.

The 5G antennas of the two base stations are situated on the roof of a six floor building and are directed towards the apartment situated on the 4th floor. Very high levels were measured in the room closest to the two base stations, with maximum peak levels of 1 200 000 and 1 120 000 µW/m² by the two windows.

Also, very high levels of RF radiation were measured at the pillows of the family member's beds. The highest level was measured in the mother's bed closest to the base stations, 374 000µW/m².

The measured levels in the apartment decreased with longer distance to the base stations and lowest levels were found in the kitchen situated on the side facing the courtyard with no base stations.

The members of the family answered a questionnaire on symptoms associated with the microwave syndrome similar to the one we have used in three previous case studies on 5G, thus allowing the possibility to compare symptoms in different persons with 5G exposure [21-23].

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The declaration of symptoms and their severity is self-assessed and the evaluation of the severity subjective. All study persons made a personal evaluation of their symptoms without influence of the other family members. This is also supported by the large difference in the reporting of health problems between the family members.

The family members declared having several symptoms typical for the microwave syndrome and were most severe in the woman aged 19. In early September 2021 the young woman experienced worsened health symptoms with development of several of the reported symptoms. She had already before the deployment of the two 5G base stations some health problems in terms of sleep disturbances, pain in the body and the joints and occasionally high pulse rate. There are no measurements of the RF microwave radiation from the previous 3G/4G base stations situated at the same spots since at least 2013. The present 5G equipment was installed during July 2021 (B in Figure 1) and during May 2022 (C in Figure 1). Although the levels in the daughter's bedroom were lower than in the other family members' bedrooms, she reported more health issues. However the levels measured at the pillow in her bedroom are far above the levels previously reported to increase risk of ill health in studies of persons living close to base stations [24], and the levels of maximum exposure recommended by the BioInitiative Report and the EuropaEM EMF Guidelines [25]. Further, it is known that the sensitivity to RF radiation can vary considerably among individuals.

The woman aged 55 years also experienced sleeping disturbances in terms of waking up in the middle of the night, starting in September 2021. This was around one and a half month after 5G was launched from the nearest base station (B in Figure 1). The young man had previously, long before the time of our measurements, noted that he felt much better sitting in the kitchen at the table, were we measured the lowest levels of RF radiation. As presented in Table 1 the study persons had a number of symptoms included in the microwave syndrome. Among those sleeping problems, headache, concentration and memory problems, skin problems, irregular heartbeat, light sensitivity, anxiety and panic attacks were reported by the woman aged 19. Concentration problems and sleep disturbances were reported by both the women and the young man.

No measurements are available of the RF radiation in the apartment before the 5G deployment. Previously there were base stations for 3G and 4G at the same two spots on the opposite side of the street facing the apartment. This is a similar situation to our previous three case studies were there were also previously 3G and 4G base stations that were replaced by 5G technology. In the first two studies [21, 22] the base stations were placed on the roof of the studied apartments, while in the third study the base station was placed on the roof of another building at a distance of 60 meters from the apartment [23], thus at a similar distance and position as in this study. Our first case study indicated that 5G causes a sharp increase in radiation exposure from 5G compared to previous technology 4G/3G [21], in line with warnings from many scientists expressed in the 5G Appeal for instance. In the 5G Appeal, scientists and medical doctors called for a moratorium on the 5G deployment due to the "massive increase of mandatory exposure" to microwaves and the fact that the health hazards of this new technology had not been previously investigated [6] (www.5gappeal.eu).

The RF radiation levels measured in this study, and in our three previous case studies on this topic, were very much higher than levels in previous generations of wireless technology found to increase the risk of ill health such as symptoms of the microwave syndrome. The distance to the base stations is within the radius also previously reported to increase the risk of similar symptoms [24, 26-31]. The RF radiation levels are also far above levels recommended by experts. In 2012, the BioInitiative Report proposed to limit human exposure to 30-60 $\mu W/m^2$ and even lower for sensitive persons and children, 3-6 $\mu W/m^2$ [32]. Also the EuropaEM EMF guidelines proposed in 2016 to limit exposure to maximum 10 – 1000 $\mu W/m^2$ and even lower at night time, 1-100 $\mu W/m^2$. For sensitive persons a maximum of 0.1-10 $\mu W/m^2$ was recommended [33].

In striking contrast to these proposed maximum exposure limits, the levels recommended by ICNIRP [2,3] and the FCC [34] are extremely much higher. According to ICNIRP 2020 proposed guidelines, exposure can be as high as 10 000 000 $\mu W/m^2$ for whole body exposure averaged over 30 minutes, thus allowing peak levels to be even very much higher [25]. Consequently, the very high peak levels observed in this case study and in previous cases studies of 5G, are still much below the ICNIRP and the FCC limits. The microwave syndrome is similar to electromagnetic hypersensitivity (EHS) [8] or electromagnetic sensitivity (EMS). However, unlike the microwave syndrome, individuals suffering from EHS can develop deliberating symptoms at extremely low exposure levels that are tolerated by most other people. That is in contrast to the very high RF radiation levels seen in our four case studies where healthy individuals, with no prior major reactions to wireless technology, developed symptoms due to levels of exposure far exceeding levels that have been reported to increase the risk of symptoms of the microwave syndrome, also called radiofrequency sickness, near mobile phone masts or base stations [24]. Several studies have also found increased risk of cancer [24]. The sensitivity to RF radiation is known to vary considerably between different persons [34-36]. Most prevalent symptoms are related to the nervous system and the heart. For occupational exposure similar symptoms, for instance headache, sleeping problems,

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heart palpitations, concentration and memory problems, were described already in 1969 [13, 14]. In 2011 the International Agency for Research on Cancer (IARC) classified RF radiation as a possible human carcinogen, Group 2B [37]. Research both on humans and laboratory animals published since 2011 confirmed the increased risk of cancer from exposure to RF radiation [1].

Conclusion

5G has been rolled out in large parts of the world without previous studies investigating possible health effects on humans or animals from exposure to 5G radiation. This case study, in line with our previous case studies, shows that two 5G base stations caused very high levels of RF radiation in the apartment where the persons in this study live. The distance to the base stations is 50 and 70 meters, respectively. The family members declared having experienced various health symptoms that have been included in the microwave syndrome. The results are in line with our previous three case studies where the study persons also reported development of similar symptoms after deployment of 5G base stations in close proximity to their living or working places. These studies are, to our knowledge, the first to have investigated health effects from 5G base stations in real life.

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Availability of Data and Materials

The information generated and analyzed during the current study is available from the corresponding author on reasonable request.

Authors' Contributions

Both authors participated in the conception, design and writing of the manuscript, and have read and approved the final version.

Ethics Approval and Consent to Participate

Not applicable.

Patient Consent for Publication

Not applicable.

Competing Interests

The authors declare that they have no competing interests.

References

1. International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF). Environ Health 21 (2022): 92.
2. International Commission on Non-Ionizing Radiation Protection (ICNIRP). Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). Health Phys 74 (1998): 494-522.
3. International Commission on Non-Ionizing Radiation Protection (ICNIRP). Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). Health Phys 118 (2020): 483-524.
4. Lin JC. Incongruities in recently revised radiofrequency exposure guidelines and standards. Environ Res 222: (2023): 115369.
5. Buchner K, Rivasi M. The International Commission on Non-Ionizing Radiation Protection: Conflicts of interest, corporate capture and the push for 5G (2021). https://www.michele-rivasi.eu/wp-content/uploads/2020/06/ICNIRP-report-FINAL-JUNE-2020_EN.pdf (2021)
6. Hardell L, Nyberg R. Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation. Mol Clin Oncol 12 (2020): 247-257.
7. Nyberg NR, McCredden JE, Weller SG, et al. The European Union prioritises economics over health in the rollout of radiofrequency technologies. Rev Env Health (2022). https://doi.org/10.1515/reveh-2022-0106
8. Carpenter DO. The microwave syndrome or electro-hypersensitivity: historical background. Rev Environ Health 30 (2015): 217-222.
9. Pollack H. The microwave syndrome. Bull NY Acad Med 55 (1979): 1240-1243.
10. Johnson-Liakouris AG. Radiofrequency (RF) sickness in the Lilienfeld study: An effect of modulated microwaves. Arch Environ Health 53 (1998): 236-238.
11. Marha K, Musil J, Tuha H. Biological effects of electromagnetic waves and their mechanism. In: Electromagnetic Fields and the Life Environment. San Francisco Press (1971): 29-38.
12. Dodge, C. Clinical and hygienic aspects of exposure to electromagnetic fields: a review. 1969. https://www.magdahavas.com/wp-content/uploads/2010/08/Dodge_1969.pdf.
13. Healer J. Review of studies of people occupationally exposed to radiofrequency-radiations. In: Biological Effects and Health Implications of Microwave Radiation. Cleary SF (Ed).U.S. Symposium Proceedings Richmond, Virginia (1969).
14. Marha K. Maximum admissible values of HF and UHF electromagnetic radiation at work places in

Nilsson M and Hardell L, J Cancer Sci Clin Ther 2023
DOI:10.26502/jcsct.5079203

Czechoslovakia. In: Biological Effects and Health Implications of Microwave Radiation. Cleary SF (Ed).U.S. Symposium Proceedings Richmond, Virginia (1969).

15. ANSES https://www.anses.fr/fr/system/files/AP2019SA0006Ra.pdf (2019).
16. Dasgupta S, Wang G, Simonich MT, et al. Impacts of high dose 3.5 GHz cellphone radiofrequency on zebrafish embryonic development. PLoS One 15 (2020): e0235869.
17. Panagopoulos DJ. Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. Mutat Res Rev Mutat Res 781 (2019): 53-62.
18. Bektas H, Algul S, Altindag F, et al. Effects of 3.5 GHz radiofrequency radiation on ghrelin, nesfatin-1, and irisin level in diabetic and healthy brains. J Chemical Neuroanatomy 126 (2022): 102160.
19. Bektas H, Dasdag S, Nalbant A, et al. 3.5 GHz radiofrequency radiation may affect biomechanics of bone and muscle of diabetics, Biotechnology Biotechnological Equip 37 (2023): 329-3383.
20. Moussa SA. Oxidative stress in rats exposed to microwave radiation. Romanian J. Biophysics 19 (2009): 149-. 158.
21. Hardell L, Nilsson M. Case Report: The microwave syndrome after installation of 5G emphasizes the need for protection from radiofrequency radiation. Ann Case Report 8 (2023): 1112.
22. Nilsson M, Hardell L. Development of the microwave syndrome in two men shortly after installation of 5G on the roof above their office. Ann Clin Case Reports 8 (2023): 2378
23. Hardell L, Nilsson M. Case Report: A 52-year healthy woman developed severe microwave syndrome shortly after installation of a 5G base station close to her apartment. Ann Clin Med Case Rep V10 (2023): 1-10.
24. Balmori A. Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer. Env Research 214 (2022): 113851.
25. Hardell L, Nilsson M, Koppel T, et al. Aspects on the International Commission on Non-Ionizing Radiation Protection (ICNIRP) 2020 guidelines on radiofrequency radiation. J Cancer Sci Clin Ther 5 (2021): 250-283.
26. Hutter HP, Moshammer H, Wallner P, et al. Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. Occup Environ Med 63 (2006): 307-313.
27. Eger H, Jahn M. Spezifische Symptome und Mobilfunkstrahlung in Selbitz (Bayern) - Evidenz für eine Dosiswirkungsbeziehung; Umwelt-Medizin-Gesellschaft 23 (2010): 130-139.
28. Alazawi SA. Mobile phone base stations health effects. Diyala J Med 1 (2011): 44-52.
29. Gómez-Perretta C, Navarro EA, Segura J, et al. Subjective symptoms related to GSM radiation from mobile phone base stations: a cross-sectional study. BMJ Open 3 (2013): e003836.
30. Khurana VG, Hardell L, Everaert J, et al. Epidemiological evidence for health risks from mobile phone base stations. Int J Env Occup Health 16 (2016): 263-267.
31. Singh K, Nagaraj A, Yousuf A, et al. Effect of electromagnetic radiations from mobile phone base stations on general health and salivary function. J Int Soc Prev Community Dent 6 (2016): 54-59.
32. BioInitiative Working Group, Cindy Sage, David O. Carpenter, Editors. BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Radiation. www.bioinititative.org (2022).
33. Belyaev I, Dean A, Eger H, et al. EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. Rev Environ Health 31 (2016): 363-397.
34. Federal Communications Commission (FCC). Proposed Changes in the Commission's Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields; Reassessment of Federal Communications Commission Radiofrequency Exposure Limits and Policies. FCC (2019): 19-126.
35. Hedendahl L, Carlberg M, Hardell L. Electromagnetic hypersensitivity – an increasing challenge to the medical profession. Rev Environ Health 30 (2015): 209-315.
36. Stein Y, Udasin IG. Electromagnetic hypersensitivity (EHS, microwave syndrome) - Review of mechanisms. Env Res 186 (2020): 109445.
37. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Non-ionizing radiation, Part 2: Radiofrequency electromagnetic fields. IARC Monogr Eval Carcinog Risks Hum 102 (2013): 1-460.