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Article

Spots with Extremely High Radiofrequency Radiation after Deployment of 5G Base Stations in Stockholm, Sweden

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Abstract: During recent years there is an on-going deployment of 5G base stations for radiofrequency (RF) communication in Sweden as well in many other countries. This is made without investigations on risks to human health and the environment. Since 2016 we have made several measurements of environmental exposure to RF radiation in Stockholm, Sweden, including previous generations and now also 5G. In the current study, performed in October 2023, the broadband meter Narda-550 with the probe EF-1891 was used. It gives results in the root mean square (RMS) mode, thus not peak levels. Both the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the US Federal Communications Commission (FCC) base their guidelines on RMS levels of RF radiation. Measurements were made in similar city areas as in our previous studies. Results show that the RF radiation has increased substantially. High maximum levels were found at e.g. the Central Railway Station (3 637 191 μW/m^2), and popular walking streets such as Mäster Samuelsgatan (11 613 976 μW/m^2), and Drottninggatan (5 271 555 μW/m^2). The peak values would be much higher. These levels are in the same magnitude or even higher than those measured in homes of persons that rapidly developed symptoms of the microwave syndrome after installation of 5G, usually in combination with 4G+, in the neighborhood. They are also substantially higher than levels that have previously been linked to cancer and the microwave syndrome in studies of people living near base stations and masts from previous generations of telecommunications.

Keywords: 5G; base stations; radiofrequency radiation; microwaves; public place; exposure

Introduction

Implementation of the fifth generation, 5G, for wireless communication started in Sweden in 2019/2020. 5G usually operates with 4G+ whereas older systems such as 2G and 3G are dismantled. 5G has caused increasing environmental radiofrequency (RF) radiation from base stations [1,2]. In spite of numerous publications and appeals asking for a moratorium the expansion of 5G continuous at its own pace [3–5]. When mobile phone base station antennas are installed, the immediate physical environment, including the public and the living spaces can be greatly affected by microwaves.

Measuring public exposure to RF fields is of importance for current both public health perspectives, but also for future epidemiological studies. In previous publications we have reported environmental exposure to RF electromagnetic (EMF) radiation at certain places in Stockholm in Sweden such as the Central Railway Station [5], the Old Town [6], with special attention to Järntorget in the Old Town [7], and Stockholm city [8]. Of special interest was to measure RF radiation in one Stockholm apartment with two groups of base station antennas nearby [9]. That apartment was further examined using a RF broadband analyzer and the results were compared with another

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Stockholm apartment with substantially much lower RF radiation but equally good wireless communication possibility [10].

In a recent case series we have presented 16 persons that developed the microwave syndrome after installation of 5G base stations in the neighborhood of their dwellings [11–17], as well as in a summary publication of all 7 case reports [18]. Thus, it seems to be of importance to make measurements of RF radiation also in the general environment [19].

The Aim of the Study

With the background of our several studies since 2016 in Stockholm of ambient RF radiation levels it was of interest to make a new study after the currently on-going implementation of 5G. In this study we identified areas in Stockholm, Sweden with an aggregation of base station antennas placed at low level, close to pedestrians' heads. The aim of this research was to identify possible highly exposed RF areas in the Stockholm city environment and to analyze the sources and the reasons for the high exposure.

Materials and Methods

In this study the similar Stockholm area as in previous studies [2,5–8] was included for measuring radiation sources. The RF radiation sources were mobile phone base station antennas located in the city. Several antennas are located only a few meters above the street level.

The sites were selected by visually identifying radiofrequency sources, based on the dense packing of mobile phone base station antennas. Furthermore, we decided to measure street areas that we have measured previously to make it possible to compare trends of RF radiation levels over time.

Study Design

The measurements were conducted daytime on October 6 to 8, 2023. The measurements were made with the Narda broadband field meter NBM-550, with the probe EF-1891, measuring frequencies between 3 MHz-18 GHz. This meter shows results in root mean square (RMS) for both minimum, maximum and average RF radiation level. Results are given both as V/m and uW/m^2.

All measurements were made while walking along the predetermined route based on our previous Stockholm measurements. Spots with high RF radiation were measured during 2 minutes at each location while walking around in a circle.

Results

The walking tour started at Stureplan Galleria, through the City, Central Station, downtown to the Old City, back along the main walking street, Drottninggatan and back to Stureplan. In this article the hot spots ae displayed at seven locations, see Table 1.

Table 1. Measuements of ambient RF radiation levels in Stockholm, Sweden October 7-8, 2023.

Narda-550 broadband meter with the probe EF-1891 was used Results are given as root mean square (RMS). NA = not analyzed.						
Place	V/m			μW/m^2		
	Min	Median	Max	Min	Median	Max
Stureplan, Galleria						
ground level	0.00	2.68	12.51	0	19 051	415 120
ground level	N.A.	10.10	28.32	N.A.	270 584	2 127 380
ground level	N.A.	3.59	7.22	N.A.	34 186	138 272
first floor	N.A.	2.02	14.47	N.A.	10 823	555 387

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Mäster Samuelsgat						
	N.A.	25.49	66.17	N.A.	1 723 449	11 613 976
	N.A.	11.81	33.70	N.A.	369 963	3 012 440
Sergel Plaza						
	3.32	12.75	35.22	29 237	431 200	3 290 314
	4.63	12.50	28.71	56 862	414 456	2 186 377
	4.01	9.69	29.36	42 653	249 061	2 286 498
Central Station						
ground level	0.00	1.97	5.08	0	10 294	68 452
Downstairs	0.00	5.00	37.03	0	66 313	3 637 191
Downstairs	8.41	14.62	28.26	187 608	566 961	2 118 376
Downstairs	2.65	9.45	19.81	18 627	236 877	1 040 945
Downstairs	6.61	13.11	23.96	115 894	455 894	1 522 763
Downstairs	2.67	5.83	15.03	18 910	90 156	599 207
Downstairs	3.54	7.69	17.86	33 240	156 860	846 100
Skeppsbron						
town side	1.67	8.45	24.45	7 398	189 397	1 585 683
town side	1.32	9.32	29.13	4 622	230 404	2 250 814
town side	5.67	14.26	30.19	85 276	539 384	2 417 602
town side	5.70	13.70	25.35	86 160	497 852	1 704 569
middle line	3.31	6.89	14.39	29 061	125 921	549 263
sea side	1.24	4.89	11.5	4 078	63 427	350 796
Järntorget						
	1.16	6.67	12.51	3 569	118 008	415 120
	3.34	6.95	10.74	29 590	128 123	305 962
Drottninggatan						
	10.06	25.53	44.58	268 445	1 728 862	5 271 555
	0.00	2.39	22.33	0	15 151	1 319 072

Stureplan Galleria

Inside Stureplan galleria highest RF radiation levels were measured close to a café area, and a maximum 28.32 V/m (2 127 380 uW/m²) was found. Overall high radiation levels were found both at the ground floor and the first floor. This galleria is much used by people for shopping, meetings at coffee shops and brasseries, retail or just walking through the galleria.

Mäster Samuelsgatan

This street takes us through Stockholm city to the Central Station area. We identified one high spot area measured to maximum 66.17 V/m (11 613 976 µW/m²). This was located opposite a market place called ARKET.

Sergel Plaza

We passed Sergel Plaza on the way to the Central Station. This is a common hub for communication and social activities. The highest measured RF radiation level was 35.22 V/m (3 290 314 uW/m²), see Table 2. This was caused by low positioned 5G antenna close to an area where people stay or walk by, see Figure 1.

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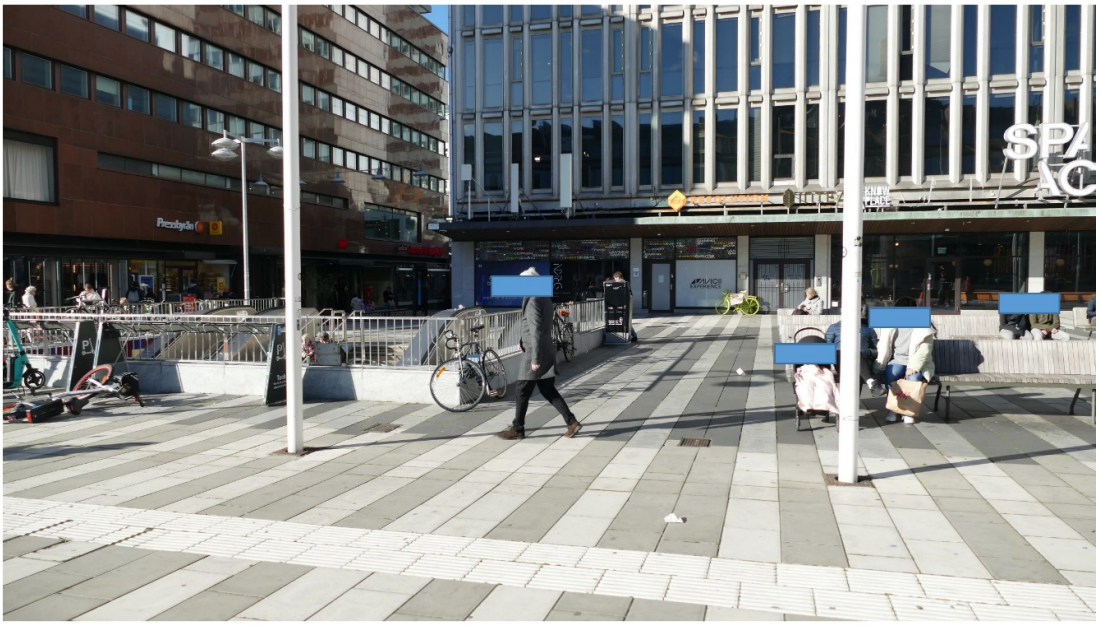

Figure 1. Base stations at Sergel Plaza, Stockholm, Sweden close to pediatricians.

Table 2. Public exposure to radiofrequency radiation in Stockholm, Sweden. Measurements were made with three different meters (selective frequency meter and broadband meters) and are therefore not quite comparable.

Study Stockholm, Sweden	**Maximum μW/m²**
Central Station, 2016 [5]	9 206 [1]
Old Town, 2017 [6]	173 302 [1]
City 2019 [8]	205 155 [1]
-Järntorget 2019 [7]	178 928 [1]
-Skeppsbron 2022 [2]	373 381 [1]
-Skeppsbron 2022 [2]	2 649 000 [2]
-Skeppsbron, town side 2023 [18]	1 180 000 to > 3 180 000 [3]
-Skeppsbrokajen, waterfront 2023 [18]	91 300 to > 3 180 000 [3]
Current study	
--Skeppsbron, town side 2023	2 471 602
--Järntorget 2023	415 120
--Central Station 2023	3 637 191
--Stureplan, Galleria 2023	2 127 380
--Mäster Samuelsgatan 2023	11 613 976
--Sergel Plaza, 2023	3 290 314
--Drottninggatan	5 271 555

[1] EME Spy selective frequency meter, upper detection limit 95 522.5 μW/m² for each measured frequency, maximum level (RMS mode). Results are given as the sum of all measured frequencies. [2)] Narda broadband meter, upper detection limit 241 000 000 μW/m², maximum level (RMS mode). [3)] Peak levels for Safe and Sound Pro II broadband meter, upper detection limit 3 180 000 μW/m².

Stockholm Central Station

Highest levels were found downstairs based on several measurements. Highest value was recorded in the area near a low positioned base station on the roof inside the building close to where people pass by or stand for check of the schedule for trains, see Figures 2 and 3.

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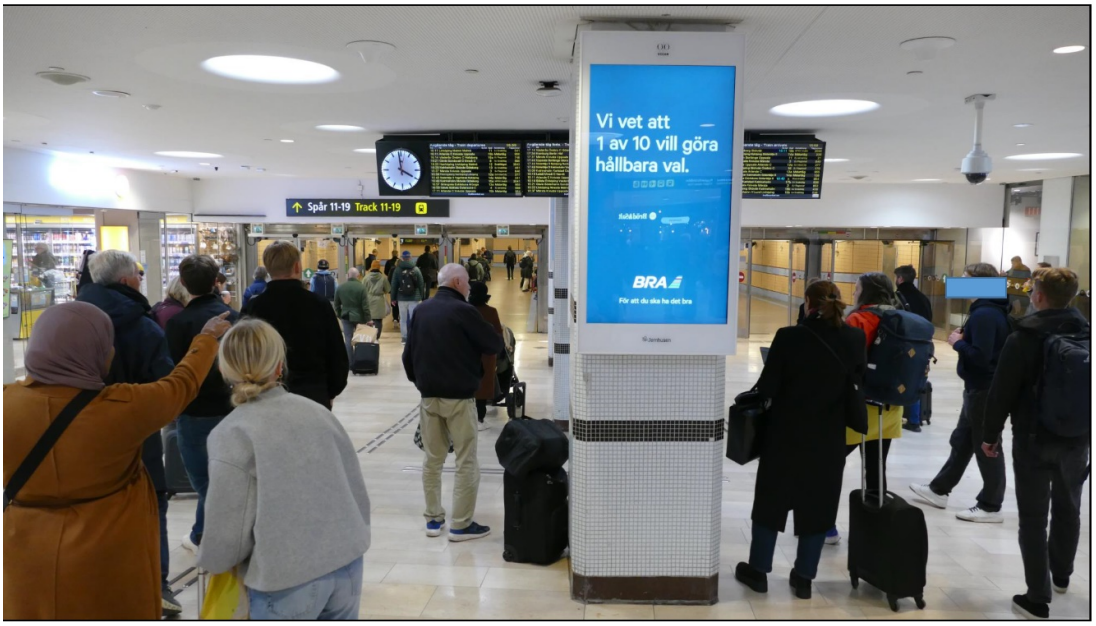

Figure 2. Base stations at Stockholm Central Railway Station, Stockholm, Sweden.

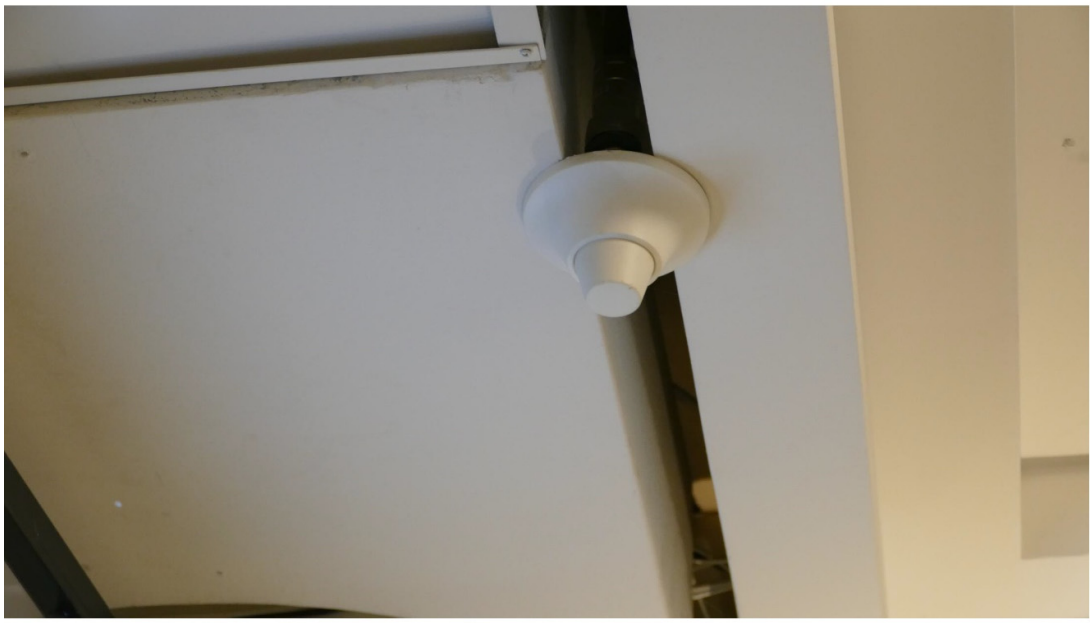

Figure 3. Microcell at Stockholm Central Railway Station, Stockholm, Sweden.

Skeppsbron, Old Town

At Skeppsbron there are several antennas placed on the roof of a one flat building, Tullhuset, see Figure 4. Most of the antennas are directed towards the Old Town opposite to the sea. Thus highest measured level was found on that side of Tullhuset, 30.19 V/m (2 417 602 uW/m^2). Also, several other measurements were high along the Skeppsbron street.

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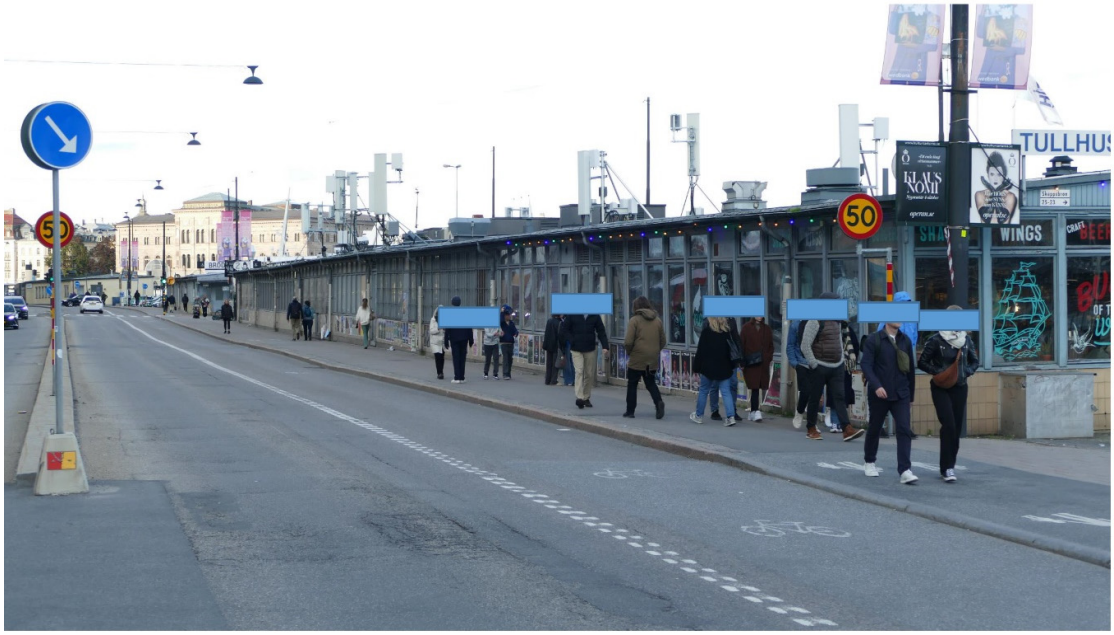

Figure 4. Low positioned base stations at Skeppsbron, Old City, Stockholm, Sweden.

Järntorget

We have previously measured high RF radiation levels at the square Järntorget in the Old town. The maximum level this time was 12.51 V/m (415 120 uW/m^2).

Drottninggatan

This is one of the main walking and shopping areas in Stockholm city. High maximum RF radiation level was identified at one place 44.58 V/m (5 271 555 μW/m^2). This was caused by low position of 5G base station (Drottninggatan-Vattugatan), see Figure 5.

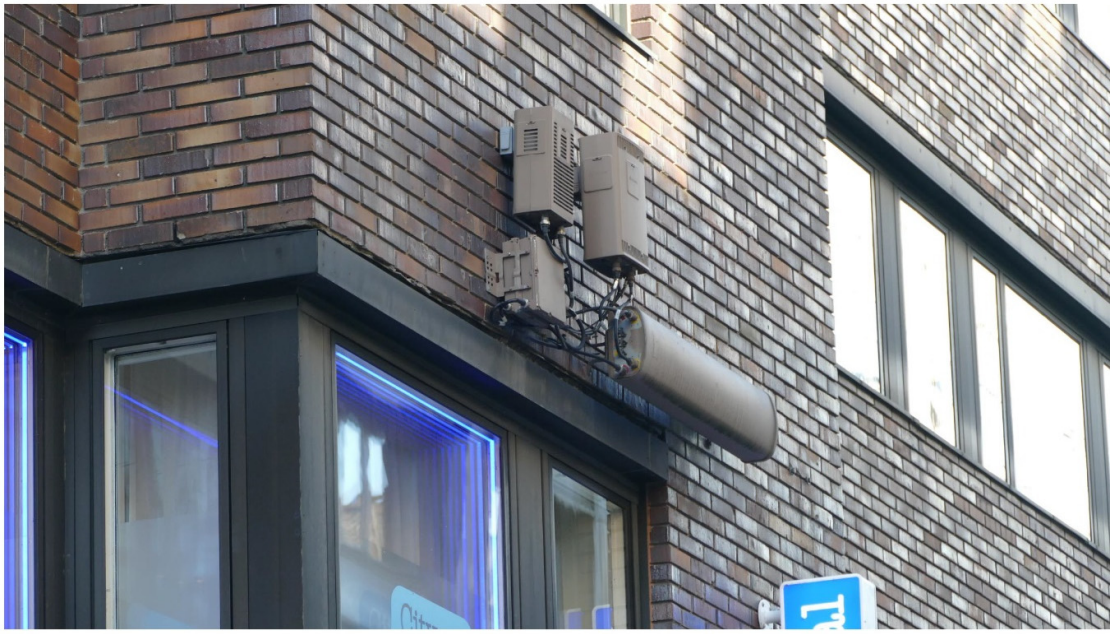

Figure 5. Low positioned base stations at Drottninggatan, Stockholm, Sweden.

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Discussion

A hotspot caused by microwave exposure from cell phone base stations may be present in public places such as streets, squares, shopping malls, and train stations. Cellular antennas and transmitters positioned on cell phone base stations can also reflect surfaces to create hotspots by the convergence of microwave signals from different sources or directions. However, typically in this study, the high levels for RF radiation were found nearby the base stations. The highest exposure levels were caused by cell phone base station antennas that were positioned relatively close to the street level. They typically emit both 4G+ and 5G wireless radiation. 2G and 3G are dismantled in Sweden.

This study showed an uneven distribution of the RF fields with several hotspots in Stockholm city identified during a walking tour in October 2023. Several base stations are located close to the people, even as low as the first floor or the ceiling within a building, e.g. the Central Railway Station. Thus, people passing by on the street or hanging around that area are highly exposed to RF radiation according to our measurements. This study demonstrated that the installment of 5G base station antennas is the reason for the highest exposure places in Stockholm city. The reason for the high exposure levels is the need to bring 5G base stations close to the subscriber devices. There may also be a tendency to hide cell phone antennas so that people are unaware of their presence, but there are also aesthetic aspects playing a role, see Figure 5.

We have published in our seven case studies persons that within short time developed the microwave syndrome after deployment of 5G base station close to their dwellings [18]. Most of the subjects were forced, if possible, to move to another place for living with no 5G base station in the neighborhood due to the severity of the symptoms. After reduction of exposure, their symptoms were reduced of disappeared within short time. Thus, these were classic examples of provocation studies. The levels that caused the rapid development of the microwave syndrome in these case studies were similar to the levels found in the current city measurements. These levels are lower than those recommended by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), but much higher than those recommended by several researchers and medical doctors without conflicts of interest.

It is clear from our measurements made so far that the implementation of 5G has indeed caused a massive increase in human and environmental exposure to pulse-modulated RF radiation. RF radiation was already in 2011 evaluated by IARC to be a possible human carcinogen Group 2B [20,21]. The association has strengthened over the years [22]

Instead of the current increasing evidence of detrimental effects on human health and the environment, extremely high and outdated guidelines by ICNIRP for maximum allowed exposure to RF radiation are used by most countries. These were first published in 1998 [23] and updated in 2020 [24]. ICNIRP's limits are based only on heating (thermal) effects from RF radiation that appear when the RF radiation is so intense that it causes acute thermal effects within an hour. These limits do not protect against non-thermal effects caused by acute or chronic exposure, although there are abundant evidence for a multitude of such effects. Similar maximum limits set by the IEEE and adopted by FCC are used in USA. (https://docs.fcc.gov/public/attachments/FCC-19-126A1_Rcd.pdf). ICNIRP is a private organization, and new members are elected by already existing members. Many have both economic and historical ties to the telecom industry [25]. The ICNIRP and the FCC limits do not protect against known health effects [22,26].

ICNIRP's thermal limits are adopted by most governments although known to allow exposure that poses risks to human health and the environment. The main reason seems to be that they are important to the telecom industry. The scientifically invalid ICNIRP and FCC approach gives industry a 'green card' to roll out 5G, as well as further generations such as 6G. 5G deployment would, according to a leading 5G infrastructure provider, be "difficult or impossible" if lower limits than those from ICNIRP were used (https://www.itu.int/en/ITU-T/Workshops-and-Seminars/20171205/Documents/S3_Christer_Tornevik.pdf). Several scientific evaluations made by independent researchers and experts have concluded that lower guidelines for RF radiation than those provided by ICNIRP and FCC are needed [27–30].

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Conclusions

RF radiation exposure levels from mobile phone base station antennas near the street level reached high levels in measurements Stockholm, Sweden made in October 2023. This study shows that 5G radiation causes very high exposure to humans walking on the street level, similar to levels found in previous case studies that caused rapid development of the microwave syndrome. Because concern of negative effects on human health as well as the environment, further deployment of 5G should be stopped until research on the safety has been made. 5G networks are currently expanding and consequently the public exposure is also likely to increase in the coming years which is contradictory to prevention of human health.

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

Conflicts of Interest: The authors declare that they have no competing interests.

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