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Comments on "Wi-Fi technology and human health impact: a brief review of current knowledge" published in the June 2022 issue of *Archives*

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The article by Prlić et al. (1) is very interesting, and we believe that it is an important and necessary publication to keep both the scientific community and the general public informed of the rapid growth of wireless technology. Here we would like to expand on the information presented in that article and comment on some new measurements of electromagnetic wave intensity [other authors prefer to call this magnitude power density (2)] from the Wi-Fi band in schools or universities (indoor/classroom or outside environment) in different countries.

In particular, we would like to complete Table 3 in Prlić's article (1) with measurements carried out in Spain, Jordan, and other countries presented here in Table 1. The last two columns of Table 1 show three significant figures (2), and the last column shows power density values in $\mu W/m^2$. The highest measured value is 86200 $\mu W/m^2$ or 0.0862 W/m^2 in three primary and three secondary schools in the United Kingdom (Table 1). This is 20.6 dB below the maximum allowed reference level of 10 W/m^2 (24).

A recently published review article (25) collected and analysed all types of studies that investigated health and biological effects of Wi-Fi exposure. The authors concluded that the measured exposure levels were several orders of magnitude below the maximum established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) of 10 W/m^2 for whole-body exposure (24).

The second important aspect that we want to comment on are non-thermal effects of radiofrequency electromagnetic fields (RF-EMF). There is a paper by Pall (26), in which he comments in a well-documented manner on seven possible EMF effects in animals and humans, with special emphasis on wireless technologies. Pall claims that repeated Wi-Fi studies (26–28) show that Wi-Fi causes oxidative stress, sperm/testicular damage, neuropsychiatric effects including EEG changes, apoptosis, cellular DNA damage, endocrine changes, and calcium overload in the organism, blocking its ionic channels. However, we believe that it is necessary to continue investigations in this direction and try to clarify current doubts, since no measurement has confirmed what Pall claims in his article.

Current controversy over possible damaging effects of 2G, 3G, and 4G wireless technologies is now being extended to the new 5G technology, whose effects on the environment and people have poorly been studied (29). It remains to be seen whether these high-frequency 5G electromagnetic waves together with an already complex combination of lower frequencies will have a negative impact on public health, both from a physical and mental perspective. We witness the first generation of people who are going to have an entire lifespan (from birth to death) immersed in a sea of man-made microwave radiofrequency waves, so it will be years or decades before they know the real health consequences.

Therefore, it makes sense to ask if Wi-Fi can have any negative effects on the health of the people, animals, or plants with which we live. To give a scientific answer to this question, research on this subject is paramount, like the one being done in many European countries. We encourage researchers in this field to carry out measurements of RF-EMF from the Wi-Fi band at schools and universities, compare their data with international regulations (22), and contribute with answers to questions that arise from growing sensitivity among citizens (1, 17, 18, 25, 29).

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Table 1 Results of personal exposure to radiofrequency electromagnetic fields from the Wi-Fi band in schools or universities (indoor/classroom or outside environment)

Author	Country	Source	E (V/m)	Power density (μW/m²)
Khalid et al. 2011 (3)	United Kingdom / 3 primary, 3 secondary schools	access points*/ 0.5	5.70[b]	86200[b]
Pyman et al. 2011 (4)		Laptops / 0.5	2.90[b]	22300[b]
Joseph et al. 2010 (5)	Hungary / 31 primary school teacher	Wi-Fi devices*	2.00–5.00[a]	10600–66300[a]
Vermeeren et al. 2013 (6)	Belgium (10 school area)	various Wi-Fi devices*#	0.0500[a], 0.240[b]	6.63[a], 153[b]
	Greece (5 school area)		0.0900[a], 0.200[b]	21.5[a], 106[b]
Verloock et al. 2014 (7)	Belgium / 5 primary and secondary schools	access points, various Wi-Fi clients*#	0.340[a], 2.52[b]	307[a], 16800[b]
Gledhill 2014 (8)	New Zealand / 2 schools	access points# / 2 laptops / <0.5	0.971[a], 2.746[b] 0.868[a], 3.36[b]	2500[a], 20000[b] 2000[a], 30000[b]
Karipidis et al. 2017 (9)	Australia / 7 primary 16 secondary schools	access points*# / 1.9	0.388[a], 3.88[b]	400[a], 40000[b]
Prlić et al. (1)	Croatia /151 primary & secondary schools	access points*# / across whole classroom (grid 1×1 m)	<0.661[b]	<1160[b]
Roser et al. 2017 (10)	Switzerland / at school	using WLAN band	0.0351[a]	3.27[a]
Kurnaz et al. 2018 (11, 12)	Turkey / inside classroom	WLAN band	0.0220[a]	1.28[a]
Fernandez 2020 (13)	Spain / inside university	Wi-Fi band	0.0310[a]	2.55[a]
Vermeeren et al. 2013 (6)	Belgium / inside schools	Wi-Fi band	0.0500[a]	6.64[a]
Hardell et al. 2017 (14)	Sweden / schools	Wi-Fi band	0.0354[a]	3.32[a]
Bhatt et al. 2016 (15)	Greece / school area	Wi-Fi band	0.0635[a]	10.7[a]
Hamiti et al. 2022 (16)	Kosovo / school area	Wi-Fi band	0.0835[a]	18.5[a]
Vermeeren et al. 2013 (6)	Greece / inside schools	2G Wi-Fi band	0.0898[a]	21.4[a]
Ramirez-Vazquez et al. 2020 (17)	Jordanian / total exposure in university area	Wi-Fi band (2G and 5G bands)	0.0931[a]	23.0[a]
Ramirez-Vazquez et al. 2020 (18)	Spain / inside school buildings	Wi-Fi band (2G and 5G bands)	0.0977[a]	25.3[a]
Ramirez-Vazquez et al. 2020 (17)	Jordanian / university area	Wi-Fi band (2G and 5G bands)	0.104[a]	28.8[a]
Hedendahl et al. 2017 (19)	Sweden / in seven schools	Wi-Fi band connection	0.158[a]	66.1[a]
Ibrani et al. 2016 and Hamiti et al. 2018 (20, 21)	Kosovo / different offices	Wi-Fi band	0.163[a]	70.2[a]
Bhatt et al. 2016 (15)	Australia / kindergarten area	Wi-Fi band	0.179[a]	85.0[a]
Verloock et al. 2014 (7)	Belgium / inside schools	Wi-Fi band	0.200[a]	106[a]
Gallastegi et al. 2018 (22)	Spain / inside classroom	different sources including Wi-Fi band	0.213[a]	120[a]
Lahham et al. 2017 (23)	Palestine / inside schools	WLAN band	0.005[a]	0.0600[a]
Lahham et al. 2017 (23)	Palestine / inside universities area)	WLAN band	0.008[a]	0.180[a]
Relevant ICNIRP reference levels[$]			**61 V/m**	**10 W/m²**

*2.4–2.5 GHz; [#]5.15–5.85 GHz. [a] average value; [b] maximum value; [$] reference levels for general public exposure to time-varying electric and magnetic fields: electric field strength and equivalent plane wave power density refer to the 2–300 GHz frequency range (24)