NEXRES 8 (2026) 101577

Contents lists available at ScienceDirect

Next Research

journal homepage: www.elsevier.com/locate/nexres

Short Communication

Wireless sensitivity and co-morbidities: A prevalence study in Australia, Canada, and the United States

Julie E. McCredden [a,*], Lyn McLean [b], Anne Steinemann [c,d]

[a] Oceania Radiofrequency Scientific Advisory Association Inc. (ORSAA) Australia
[b] EMR Australia PL, Sydney, Australia
[c] Department of Infrastructure Engineering, The University of Melbourne, Parkville, Victoria, 3010, Australia
[d] College of Science and Engineering, James Cook University, Townsville, Queensland, 4814, Australia

ARTICLE INFO

Keywords:
Wireless sensitivity
Sensitivity
Electromagnetic radiation
EMF exposure
Health
Radiofrequency radiation

ABSTRACT

Wireless radiation—such as from cell phones, Wi-Fi, smart meters, laptops, and cell towers—is pervasive in society. Wireless sensitivity is the condition of adverse health effects from exposure to wireless radiation. This study investigates the prevalence of wireless sensitivity, and the medical diagnosis of electromagnetic hypersensitivity (EHS), in the general population of three countries: the United States (US), Australia (AU), and Canada (CA). It also investigates the prevalence of wireless sensitivity/EHS with co-morbid conditions: chemical sensitivity/multiple chemical sensitivities (MCS), asthma/asthma-related conditions (ARCs), autism/autism spectrum disorders (ASDs), and fragrance sensitivity. Nationally representative population-based data were collected in February 2022 (US, AU) and May 2022 (CA) through online surveys of adults [n=3,475 (1,271; 1,104; 1,100) US, AU, CA, respectively]. The study found that, across the general population, 12.6% reported wireless sensitivity (12.8%, 17.4%, 7.5%), 10.0% reported medically diagnosed electromagnetic hypersensitivity (EHS) (10.1%, 14.9%, 5.0%), and 14.0% reported either or both (14.3%, 18.9%, 8.7%). Among all gender and age categories, males ages 25 to 34 reported the highest prevalence proportionally. In addition, among those with wireless sensitivity/EHS, 80.6% also reported chemical sensitivity/MCS, 73.2% reported asthma/ARCs, 53.8% reported autism/ASDs, and 84.8% reported fragrance sensitivity. Given these results, across the three countries, over 26 million adults would experience health problems from wireless radiation. Results underscore the need for further research on ways to prevent and reduce exposures and associated adverse effects.

Introduction

Wireless radiation is a common environmental pollutant. People are exposed to emissions from hundreds of sources, such as mobile phones, tablets, laptops, modems, smart meters, household appliances, baby monitors, medical devices, cars, antennas, Wi-Fi networks, and public transport. Exposure is ubiquitous, difficult to avoid, and likely to increase [1].

Wireless sensitivity, as termed in this study, is the experience of adverse health symptoms from exposure to wireless (radiofrequency) radiation. Common symptoms include headaches, dizziness, cardiovascular problems, tinnitus, difficulty concentrating, nervous system effects, irritability, insomnia, fatigue, burning face, nausea, and dysesthesia, among others [2,3]. Adverse effects typically occur during exposure, yet can also occur after exposure, and be so severe as to be disabling [4,5]. Wireless sensitivity is also known as electromagnetic hypersensitivity (EHS), [6] although EHS encompasses sensitivity to other types of electromagnetic fields (EMFs) [7].

Research over several decades has demonstrated that exposure to EMFs, even at very low levels, can cause a range of adverse biological effects, including non-thermal[1] effects [8–10]. This research has also found that EHS is associated with increased exposure to EMFs [11,12]. Given the proliferation of wireless technology and the health consequences of exposure, [13] it is important to understand the prevalence of wireless sensitivity. Previous national population-based studies found the prevalence of EHS to be 3.5% (Austria), [14]. 5% (Switzerland), [15]. 5.3% (Japan), [16]. 10.3% (Germany), [17]. and 13.3% (Taiwan) [18]. Other large-scale regional studies found the prevalence to be 3.2%

* Corresponding author.
E-mail address: julie.mccredden@orsaa.org (J.E. McCredden).

[1] "Non-thermal effects" refers to effects not related to excessive tissue heating.

https://doi.org/10.1016/j.nexres.2026.101577
Received 26 February 2026; Received in revised form 5 March 2026; Accepted 6 March 2026
Available online 7 March 2026
3050-4759/© 2026 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC license (http://creativecommons.org/licenses/by-nc/4.0/).

(California, USA), [19]. 1.6% (Österbotten, Finland) and 2.7% (Västerbotten, Sweden) [20]. In addition, electromagnetic radiation has been linked with other sensitivity-related illnesses, [21] such as multiple chemical sensitivity, [22,23]. fragrance sensitivity, [24]. asthma, [25]. and autism [26].

This study investigated the prevalence of wireless sensitivity in the general population of the United States, Australia, and Canada. It also investigated co-prevalences between wireless sensitivity and other conditions: chemical sensitivity/MCS, asthma/ARCs, autism/ASDs, and fragrance sensitivity. To our knowledge, this is the first national population study of wireless sensitivity, its medical diagnosis, and co-morbid conditions in these three countries. Population-level adverse health effects are relevant to sustainability practice because they can affect environmental decision-making, societal access, and economic productivity, and thus influence the perceived benefits of wireless-enabled interventions.

This study contributes to sustainability knowledge and practice by providing population-based estimates of the prevalence of reported adverse health effects from exposure to wireless radiation. Sustainability initiatives increasingly rely on wireless technologies to support, for instance, energy efficiency, digital connectivity, and smart infrastructure. However, to be truly sustainable, wireless systems also need to support human health.

Methods

Nationally representative cross-sectional population surveys of adults (ages 18–65) were conducted in the US, AU, and CA. Population samples (n=1,271; 1,104; 1,100; respectively) were statistically matched to age, gender, and region for the general population (confidence limit = 95%, margin of error = 3%, for each country). The survey instrument was a questionnaire, developed and tested over a two-year period (2020-2022), including cognitive testing and validation with five individuals and piloting with over 100 individuals, in each country (2022), before full implementation in February 2022 (US, AU) and May 2022 (CA).

Participants were randomly recruited from large web-based panels, provided by Survey Sampling International/Dynata (SSI/D). Participant recruitment followed a three-stage process: first, participants were randomly selected from SSI/D panels and invited to take an on-line survey; second, participants were combined with others into SSI/D's sampling platform and responded to randomly selected profiling questions; and third, prospective participants were then randomly assigned to a survey. Participants were recruited for the survey until the final sample was statistically representative of the general population for gender, age, and region. Informed consent was obtained. Completion rates were 89% (US), 96% (AU), and 91% (CA), and all responses were anonymous. (See the ESM, "Survey Methodology," "Questionnaire," "STROBE Flow Diagram," and "SSI/Dynata Methodologies.")

The survey investigated environmental exposures (wireless radiation, chemicals, fragranced products) and associated effects in the general population. This paper reports specific results for the prevalence of wireless sensitivity/EHS and its overlaps with co-morbid conditions from a broader survey of environmental exposure conditions. The survey instrument was focused on prevalence of these conditions rather than a more detailed characterisation of exposure sources, doses, and symptoms for each condition.

The survey instrument employed the following questions to assess prevalence:

Wireless sensitivity: "Do you consider yourself allergic or unusually sensitive to wireless radiation, such as from cell phones, Wi-Fi, smart meters, laptops, and other types of wireless technologies and devices?"

Medically diagnosed EHS (electromagnetic [hyper]sensitivity): "Has a doctor or health care professional ever told you that you have electromagnetic sensitivity?"

Chemical sensitivity: "Compared to other people, do you consider yourself allergic or unusually sensitive to everyday chemicals like those in household cleaning products, paints, perfumes, detergents, insect spray and things like that?"

Medically diagnosed MCS (multiple chemical sensitivities): "Has a doctor or health care professional ever told you that you have multiple chemical sensitivities?"

Asthma/asthma-like conditions (ALCs): "Has a doctor or health care professional ever told you that you have asthma or an asthma-like condition?"

Autism/autism spectrum disorders (ASDs): "Has a doctor or health care professional ever told you that you have autism or autism spectrum disorder?"

Fragrance sensitivity: "Do you experience any health problems when exposed to (fragranced product)?" Products include, among others, air fresheners, deodorizers, laundry products, cleaning supplies, personal care products, essential oils, pandemic products, and hand sanitizers [27]. An individual was considered to characterize fragrance sensitivity if they reported one or more types of health problems from exposure to one or more types of fragranced consumer products.

Descriptive statistics and cross-tabulations indicated the relative prevalence of each condition in each country and sub-population. Chi-squared (χ^2) analyses determined whether a significant relationship exists between (A) wireless sensitivity/EHS and each co-morbid condition and (B) wireless sensitivity/EHS and gender and age subgroups. (See the ESM, "Chi-squared analysis, Part A and Part B.")

Results

Main findings are presented below and summarized in Table 1 and Table 2. When country-specific data are presented in series, they refer to US, AU, and CA, respectively. (See the ESM, "Response Data and Statistical Analysis.")

Across the general population surveyed in the three countries, 12.6% reported wireless sensitivity (12.8%, 17.4%, 7.5%), 10.0% reported EHS (10.1%, 14.9%, 5.0%), and 14.0% reported either or both (wireless sensitivity/EHS) (14.3%, 18.9%, 8.7%). (See Table 1 and Fig. 1) Among those with wireless sensitivity/EHS, 89.3% reported wireless sensitivity (89.6%, 91.9%, 86.5%) and 68.9% reported EHS (70.9%, 78.5%, 57.3%). Thus, given current population data, wireless sensitivity affects an estimated 26.7 million adults across the three countries (22.3 million US, 2.6 million AU, 1.8 million CA).

The prevalence of each co-morbid condition was significantly higher (more than three times) for individuals with wireless sensitivity/EHS than without: chemical sensitivity/MCS (80.6%, 19.4%), asthma/ARCs (73.2%, 23.3%), autism/ASDs (53.8%, 2.5%), and fragrance sensitivity (84.8%, 25.7%), as illustrated in Fig. 2. (See also Table 1, and the ESM "Chi-squared analysis, Part A.") Furthermore, at least one-third of individuals with each co-morbid condition also reported wireless sensitivity/EHS: chemical sensitivity/MCS (39.7%); asthma/ALCs (33.3%); autism/ASDs (77.0%); and fragrance sensitivity (34.7%). (See Table 1.)

Wireless sensitivity affected proportionally more males (+6.7%) than females, relative to the general population. Among all gender and age groups, the most affected proportionally were males ages 25-34 (+8.2%), and the second most affected were males ages 35-44 (+5.3%), relative to gender/age percentages in the general population. Also, a greater relative proportion of males (compared to females) was found in the group with wireless sensitivity/EHS than in the group without wireless sensitivity/EHS. This pattern was significant for the overall sample, and for two sub-groups: ages 25-34 and ages 35-44 (see Table 2 and the ESM, "Chi-squared analysis, Part B."). These results indicate that the identification or diagnosis of EHS is not just due to chance, and that those most affected by EHS proportionally are males ages 25-44.

The higher prevalence of wireless/EHS in younger males may seem inconsistent with prior studies that found a higher prevalence in females. However, several past studies were biased towards finding a

Table 1
Prevalences and Co-Prevalences of Wireless Sensitivity, Medically Diagnosed Electromagnetic (Hyper)sensitivity (EHS), and Wireless Sensitivity/Diagnosed EHS.

	US	AU	CA	Average
n (number of participants)	1271	1104	1100	
Wireless Sensitivity	**12.8%**	**17.4%**	**7.5%**	**12.6%**
Diagnosed EHS	**10.1%**	**14.9%**	**5.0%**	**10.0%**
Wireless Sensitivity/EHS	**14.3%**	**18.9%**	**8.7%**	**14.0%**
Wireless Sensitivity	89.6%	91.9%	86.5%	89.3%
Diagnosed EHS	70.9%	78.5%	57.3%	68.9%
Chemical Sensitivity/MCS	83.5%	90.4%	67.7%	80.6%
Asthma/ALCs	67.6%	84.2%	67.7%	73.2%
Autism/ASDs	52.7%	74.2%	34.4%	53.8%
Fragrance Sensitivity	81.3%	92.8%	80.2%	84.8%
Not Wireless Sensitivity/Not EHS	**85.7%**	**81.1%**	**91.3%**	**86.0%**
Chemical Sensitivity/MCS	19.7%	19.0%	19.4%	19.4%
Asthma/ALCs	26.3%	24.0%	19.6%	23.3%
Autism/ASDs	2.5%	3.6%	1.4%	2.5%
Fragrance Sensitivity	26.4%	23.5%	27.2%	25.7%
Chemical Sensitivity/MCS				
Wireless Sensitivity	37.4%	49.0%	22.7%	36.4%
Diagnosed EHS	33.3%	43.5%	16.5%	31.1%
Wireless Sensitivity/EHS	41.5%	52.6%	25.0%	39.7%
Asthma/ALCs				
Wireless Sensitivity	27.6%	41.7%	21.4%	30.2%
Diagnosed EHS	24.7%	38.1%	16.4%	26.4%
Wireless Sensitivity/EHS	30.1%	45.0%	24.8%	33.3%
Autism/ASDs				
Wireless Sensitivity	72.4%	78.6%	61.7%	70.9%
Diagnosed EHS	69.1%	74.3%	51.1%	64.8%
Wireless Sensitivity/EHS	78.0%	82.9%	70.2%	77.0%
Fragrance Sensitivity				
Wireless Sensitivity	31.0%	44.3%	18.9%	31.4%
Diagnosed EHS	26.8%	39.9%	14.6%	27.1%
Wireless Sensitivity/EHS	33.9%	48.0%	22.0%	34.7%

Table interpretation: The rows in bold indicate the prevalence in the general population, and rows in plain text indicate the co-prevalences. For instance, for Wireless Sensitivity/EHS, for the US, the prevalence among the general population is 14.3%, and, among those individuals, 52.7% report autism/ASDs. Among those with autism/ASDs, for the US, 78.0% report Wireless Sensitivity/EHS. The interpretation of "Wireless Sensitivity/EHS" is (Wireless Sensitivity) OR (Diagnosed EHS) OR (both Wireless Sensitivity AND Diagnosed EHS). The interpretation of "NOT Wireless Sensitivity/NOT EHS" is (NOT Wireless Sensitivity) OR (NOT Diagnosed EHS) OR (both NOT Wireless Sensitivity AND NOT Diagnosed EHS).

relatively higher female prevalence due to inclusion of proportionally more females in the study [28]. Moreover, recent studies on environmental sensitivities found a relatively higher prevalence among young males [29].

For study strengths, sample populations were statistically representative of age, gender, and region in each country; participants were randomly recruited from large web-based panels; and the survey employed questions from prior national population-based studies [30]. For study limitations, only adults aged 18–65 were included; the survey relied on self-reported data; the study was not designed to clinically validate the symptoms or the bases for the medical diagnosis; and specific sources and associated health effects were not queried. We note that diagnostic criteria and mechanisms for EHS remain debated. This study does not address causation, but estimates population prevalence of self-reported wireless sensitivity and medically diagnosed electromagnetic sensitivity.

Further, the survey was conducted on-line, which necessarily required that participants were able to access the internet. This could influence the prevalence results, in either direction, higher or lower. For instance, an internet survey may prevent individuals with EMF sensitivity from participating (lower). However, EMF sensitive individuals can often use the internet safely with alternative access methods (e.g., wired connections), and as a source of employment (higher). Internet users may experience more EMF exposure and thus EMF symptoms (higher). However, those individuals may not recognise or attribute the source of symptoms to use of the internet (lower). In any case, the study results provide a motivation and foundation for more detailed investigations of wireless sources, exposures, and effects.

Discussion

This study illuminated the prevalence of wireless sensitivity and associated co-morbidities in the United States, Australia, and Canada. It found a higher prevalence of sensitivity than previous prevalence studies conducted in other countries. Possible reasons are that people have been exposed to more wireless radiation, over a longer period of time, and from a wider range of frequencies. It has been shown that intensity, exposure duration, and modulation can all influence the biological effects of a signal [31].

The prevalence results from this study may yet underestimate the true prevalence of this condition. People experiencing symptoms of wireless sensitivity may not recognize wireless radiation as a possible cause. Medical professionals may not consider or diagnose wireless sensitivity/EHS. Further, the online format of the survey may preclude participation by individuals with wireless sensitivity/EHS. On the other hand, heavier internet users may experience more EMF exposure, depending on the technology, and thus symptoms of wireless sensitivity/EHS. Also, sensitive individuals may nonetheless be able to use the internet, with alternative means of access, such as wired connections.

A striking finding was the relatively high co-prevalence of wireless sensitivity with other conditions. Among individuals with wireless sensitivity/EHS, 80.6% had chemical sensitivity/MCS; 84.8% had fragrance sensitivity; 73.2% had asthma/ARCs and 53.8% had autism/ASDs. Conversely, for each co-morbid condition, the prevalence of EHS/wireless sensitivity was chemical sensitivity/MCS (39.7%), fragrance sensitivity (34.7%), asthma/ALCs (33.3%), and autism/ASDs (77.0%). These results suggest possible shared pathophysiological mechanisms between wireless sensitivity/EHS and each of these conditions.

Previous research has found that chemical sensitivity and EHS have similar pathologies, including neuroinflammation, oxidative/nitrosative stress, and blood-brain-barrier disruption [32,33]. Additional research has shown a nitric-oxide link with wireless sensitivity/EHS, chemical sensitivity/CFS, asthma, and autism [34,35]. Studies have also found shared pathophysiological features of neurodegeneration and MCS, such as oxidative stress, systemic inflammation, and upregulation of TRPV1 and TRPA1 receptors, with implications for environmental exposures and sensitivity related diseases [36]. The links between the conditions investigated in our study reinforce the need for further research on co-prevalence and pathophysiology [37].

Wireless technologies are increasingly embedded in "smart" sustainability initiatives. If nearly 12% of the population experiences adverse effects from wireless, this has implications for human and environmental health, societal participation, and the full accounting of costs and benefits. These findings, therefore, inform sustainability practice by identifying a health-related factor that may affect net sustainability outcomes.

Our findings have clear implications for sustainability. Environmentally, wireless radiation may be considered an environmental pollutant, and population-level wireless sensitivity may act as a sentinel health response, providing an early warning of broader environmental stress. Socially, with nearly one in seven adults affected, wireless sensitivity raises equity and accessibility concerns, as wireless-dependent environments can unintentionally exclude affected individuals from workplaces, services, and public life. Economically, at this scale, wireless sensitivity entails hidden costs, including reduced workforce participation and productivity and increased healthcare costs, that may not be captured in traditional cost–benefit analyses.

Table 2
Demographic results from the surveys. Proportions by gender/age category among the general population versus the sub-population of wireless sensitive/diagnosed EHS.

Subgroups	General Population				Wireless Sensitive/Diagnosed EHS				$\Delta^{(2-1)}$	Chi-squared test*
	US	**AU**	**CA**	**Sum/Ave[1]**	**US**	**AU**	**CA**	**Sum/Ave[2]**		
	1271	**1104**	**1100**	**3475**	**182**	**209**	**96**	**487**		
All Males	616	547	456	1619	114	109	43	266		$\chi_1^2 = 14.3;\ p \leq 0.01$
	48.5%	49.5%	41.5%	46.5%	62.6%	52.2%	44.8%	53.2%	6.7%	
All Females	655	557	644	1856	68	100	53	221		
	51.5%	50.5%	58.5%	53.5%	37.4%	47.8%	55.2%	46.8%	-6.7%	
Male 18-24	86	80	47	213	23	25	5	53		$\chi_1^2 = 1.43; NS$
	6.8%	7.2%	4.3%	6.1%	12.6%	12.0%	5.2%	9.9%	3.8%	
Female 18-24	112	86	92	290	14	35	9	58		
	8.8%	7.8%	8.4%	8.3%	7.7%	16.7%	9.4%	11.3%	2.9%	
Male 25-34	143	111	95	349	30	45	16	91		$\chi_1^2 = 8.83; p \leq 0.01$
	11.3%	10.1%	8.6%	10.0%	16.5%	21.5%	16.7%	18.2%	8.2%	
Female 25-34	130	127	150	407	19	32	18	69		
	10.2%	11.5%	13.6%	11.8%	10.4%	15.3%	18.8%	14.8%	3.0%	
Male 35-44	137	107	99	343	38	27	11	76		$\chi_1^2 = 10.7;\ p \leq 0.01$
	10.8%	9.7%	9.0%	9.8%	20.9%	12.9%	11.5%	15.1%	5.3%	
Female 35-44	141	155	135	431	19	24	13	56		
	11.1%	14.0%	12.3%	12.5%	10.4%	11.5%	13.5%	11.8%	-0.6%	
Male 45-54	129	120	111	360	19	10	9	38		$\chi_1^2 = 5.37; NS$
	10.1%	10.9%	10.1%	10.4%	10.4%	4.8%	9.4%	8.2%	-2.2%	
Female 45-54	156	124	150	430	9	8	8	25		
	12.3%	11.2%	13.6%	12.4%	4.9%	3.8%	8.3%	5.7%	-6.7%	
Male 55-65	121	129	104	354	4	2	2	8		$\chi_1^2 = 3.02; NS$
	9.5%	11.7%	9.5%	10.2%	2.2%	1.0%	2.1%	1.7%	-8.5%	
Female 55-65	116	65	117	298	7	1	5	13		
	9.1%	5.9%	10.6%	8.6%	3.8%	0.5%	5.2%	3.2%	-5.4%	

Notes: $\Delta^{(2-1)}$ = difference between (2) the proportion in the wireless sensitivity/EHS sub-population and (1) the proportion in the general population. Positive/negative numbers indicate a higher/lower proportion of the wireless sensitivity/EHS sub-population relative to the general population. Sums/averages are across all three countries.
The interpretation of "Wireless Sensitive/Diagnosed EHS" is (Wireless Sensitive) OR (Diagnosed EHS) OR (both Wireless Sensitive AND Diagnosed EHS). The interpretation of "NOT Wireless Sensitive/NOT Diagnosed EHS" is (NOT Wireless Sensitive) OR (NOT Diagnosed EHS) OR (both NOT Wireless Sensitive AND NOT Diagnosed EHS).
* (Males | Females) x (Wireless Sensitivity/EHS | No Wireless Sensitivity/No EHS). For the full Chi-squared tests for gender and age groups see the ESM, "Chi-Squared Analysis, PartB."

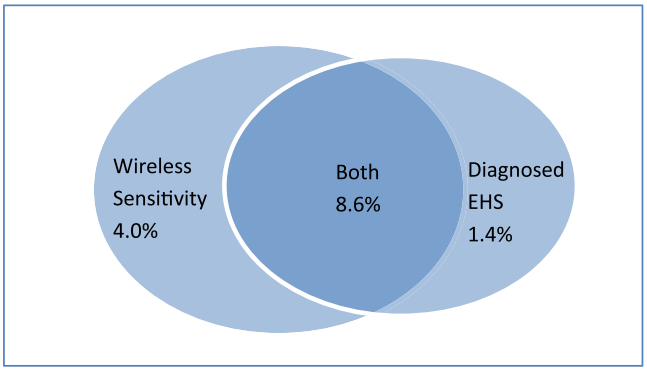


Fig. 1. Venn diagram showing the prevalence of Wireless Sensitivity, Diagnosed EHS, and Both, using averages across US, AU, CA
Wireless Sensitivity OR Diagnosed EHS OR Both = 14.0%
Neither Wireless Sensitivity NOR Diagnosed EHS = 86.0%.

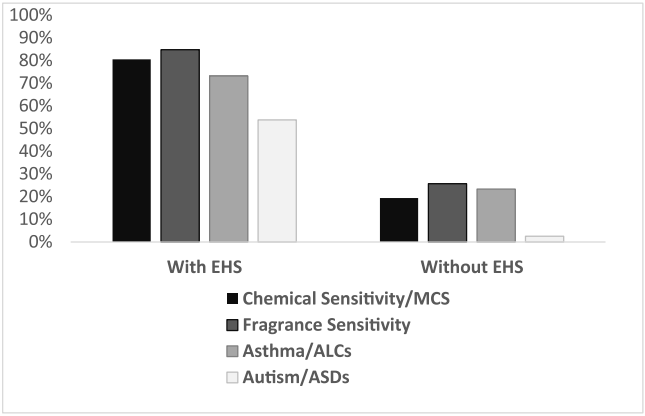


Fig. 2. The significantly higher proportions of respondents with Wireless Sensitivity/EHS who reported co-morbid conditions compared to the proportion of respondents without Wireless Sensitivity/EHS who reported co-morbid conditions. (All relationships are statistically significant at $p < 0.001$).

Conclusions

National population surveys in the United States, Australia, and Canada showed that 12.6% (12.8%, 17.4%, 7.5%) of adults reported wireless sensitivity, affecting an estimated 26.7 million adults across the three countries. In addition, 10.0% of adults reported receiving a medical diagnosis of EHS, and 14.0% reported having wireless sensitivity/EHS. Vulnerable individuals with other health conditions—such as chemical sensitivity, asthma, autism, and fragrance sensitivity—are proportionally even more affected. Among all gender and age groups, the relatively most affected by wireless sensitivity was males ages 25-34. Results accentuate the need for further research on specific sources and associated health effects; disease mechanisms underlying wireless sensitivity; and ways to prevent and reduce exposures (such as through alternative means to access the internet) and improve public health.

Given that wireless radiation affects an estimated one in seven adults, the race to implement new wireless technologies under the rubric of "sustainability" needs parallel consideration of possible effects on the environment, social equity, and economics. Reducing exposures to wireless radiation can improve outcomes for sustainability. Environmentally, reducing exposures may lessen potential harm to human

health and environmental systems. Socially, reducing exposures may lower barriers to access and participation and productivity in wireless-dependent workplaces, services, and public spaces. Economically, reducing exposures may decrease costs associated with lost workforce participation and increased healthcare needs.

Declaration

Ethics approval was obtained by the University of Melbourne, School of Engineering Human Ethics Advisory Group, application 2057851 on October 10, 2020. All respondents provided informed consent to participate in the study via the SSI/D web-based panel. (See the ESM, "Survey Methodology" and "SSI/Dynata Methodologies.") The design, execution and reporting of this study followed the STROBE guidelines for observational studies in epidemiology. (See the ESM, "STROBE Checklist.")

Data availability statement

Data associated with the study is publicly available in the Electronic Supplementary Material associated with this manuscript.

CRediT authorship contribution statement

Julie E. McCredden: Writing – review & editing, Writing – original draft, Visualization, Validation, Formal analysis. **Lyn McLean:** Writing – review & editing, Writing – original draft, Validation. **Anne Steinemann:** Writing – original draft, Visualization, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We thank Victor Leach, Steven Weller, Don Maisch, Don Smith, and Neda Nematollahi for their very helpful contributions, and gratefully acknowledge the bequest of the late Bruce Rowe, used to support this work. We also thank Dynata for their work on the surveys. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.nexres.2026.101577.

References

[1] N.R. Nyberg, J. McCredden, S. Weller, L. Hardell, The European union prioritises economics over health in the rollout of radiofrequency technologies, Rev. Environ. Health (2022), https://doi.org/10.1515/reveh-2022-0106.
[2] D. Belpomme, L. Hardell, I. Belyaev, E. Burgio, DO. Carpenter, Thermal and non-thermal health effects of low intensity non-ionizing radiation: an international perspective, Environ. Pollut. 242 (2018) 643–658.
[3] M. Havas, Radiation from wireless technology affects the blood, the heart, and the autonomic nervous system, Rev. Environ. Health 28 (2-3) (2013) 75–84.
[4] WHO (World Health Organization), Electromagnetic fields and public health, Electromagnetic Hypersensitivity, 2005. WHO Fact Sheet No. 296;World Health Organization: Geneva, Switzerland. [note: this was republished by the U.S. government, https://www.nrc.gov/docs/ML0832/ML083260827.pdf.
[5] O. Johansson, Electrohypersensitivity: state-of-the-art of a functional impairment, Electromagn. Biol. Med. 25 (4) (2006) 245–258.
[6] U. Bergqvist, E. Vogel, EDS: possible health implications of subjective symptoms and electromagnetic fields. a report prepared by a European group of experts for the European Commission, DGV. Arbete och Hälsa, 19, Swedish National Institute for Working Life, Stockholm, Sweden, 1997. ISBN 91-7045-438-8 (in Swedish).
[7] W.J. Rea, Y. Pan, E.F. Fenyves, I. Sujisawa, H. Suyama, N. Samadi, GH. Ross, Electromagnetic field sensitivity, J. Bioeletricity 10 (1991) 214–225, 1991.
[8] DI. McRee, Soviet and eastern european research on biological effects of microwave radiation, Proceed. IEEE 68 (1) (1980) 84–91. Jan, https://www.aveaate.org/IMG/pdf/mcree80_rev_soviet.pdf.
[9] World Health Organization, Electromagnetic fields 300 Hz to 300 GHz, Environmental Health Criteria, Geneva, 1993, 137, https://iris.who.int/bitstream/handle/10665/37112/WHO_EHC_137_eng.pdf.
[10] H. Lai, BB. Levitt, Cellular and molecular effects of non-ionizing electromagnetic fields, Rev. Environ. Health (2023), https://doi.org/10.1515/reveh-2023-0023. Apr 7.
[11] Belpomme D, Irigaray P 2022. Why electrohypersensitivity and related symptoms are caused by non-ionizing man-made electromagnetic fields: An overview and medical assessment Environmental Research, 212(A): 113374.
[12] L. Hardell, M. Nilsson, Summary of seven Swedish case reports on the microwave syndrome associated with 5G radiofrequency radiation, Rev. Environ. Health (2024), https://doi.org/10.1515/reveh-2024-0017.
[13] R.N. Kostoff, P. Heroux, M. Aschner, A. Tsatsakis, Adverse health effects of 5G mobile networking technology under real-life conditions, Toxicol. Lett. 323 (2020) 35–40. May 1.
[14] J. Schröttner, N. Leitgeb, Sensitivity to electricity – temporal changes in Austria, BMC Public Health 8 (2008) 310.
[15] N. Schreier, A. Huss, M. Röösli, The prevalence of symptoms attributed to electromagnetic field exposure: a cross-sectional representative survey in Switzerland, Soz. Praventiv. Med. 51 (2006) 202–209.
[16] X. Lu, S. Hojo, A. Mizukoshi, et al., Prevalence and correlation of multiple chemical sensitivity and electromagnetic hypersensitivity with age, sex, and depression in the Japanese population: a retrospective study, BMC Public Health 23 (2023) 1205.
[17] M. Blettner, B. Schlehofer, J. Breckenkamp, B. Kowall, S. Schmiedel, U. Reis, P. Potthoff, J. Schüz, G. Berg-Beckhoff, Mobile phone base stations and adverse health effects: phase 1 of a population-based, cross-sectional study in Germany, Occup. Environ. Med. 66 (2009) 118–123.
[18] M.C. Tseng, Y.P. Lin, T.J. Cheng, Prevalence and psychiatric comorbidity of self-reported electromagnetic field sensitivity in Taiwan: a population-based study, J Formos Med. Assoc. 110 (10) (2011) 634–641.
[19] P. Levallois, R. Neutra, G. Lee, L. Hristova, Study of self-reported hypersensitivity to electromagnetic fields in California, Environ. Health Perspect. 110 (2002) 619–623.
[20] K. Karvala, M. Sainio, E. Palmquist, M.H. Nyback, S. Nordin, Prevalence of various environmental intolerances in a Swedish and Finnish general population, Environ. Res. 161 (2018) 220–228.
[21] SJ. Genuis, Sensitivity-related illness: the escalating pandemic of allergy, food intolerance and chemical sensitivity, Sci. Total Environ. 408 (24) (2010) 6047–6061.
[22] D. Belpomme, C. Campagnac, P. Irigaray, Reliable disease biomarkers characterizing and identifying electrohypersensitivity and multiple chemical sensitivity as two etiopathogenic aspects of a unique pathological disorder, Rev. Environ. Health. 30 (2015) 251–271, 2015.
[23] D. Belpomme, P. Irigaray, Combined neurological syndrome in electrohypersensitivity and multiple chemical sensitivity: a clinical study of 2018 Cases, J. Clinic. Med. 12 (23) (2023) 7421, no.
[24] PR. Gibson, Chemical and electromagnetic exposures as disability barriers: environmental sensitivity, Disability Soc. 24 (2009) 187–199.
[25] S. Gangi, O. Johansson, A theoretical model based upon mast cells and histamine to explain the recently proclaimed sensitivity to electric and/or magnetic fields in humans, Med. Hypotheses 54 (4) (2000) 663–671.
[26] M.R Herbert, C. Sage, Autism and EMF? Plausibility Pathophysiol. link part I and II 20 (3) (2013) 211–234, 191-209.
[27] A. Steinemann, International prevalence of fragrance sensitivity, Air. Qual. Atmos. Health 12 (8) (2019) 891–897.
[28] M.J. Hagström, J.R. Auranen, R. Ekman, Electromagnetic hypersensitive finns: symptoms, perceived sources and treatments, a questionnaire study, Pathophysiology 20 (2) (2013) 117–122.
[29] A. Steinemann, International prevalence of chemical sensitivity, co-prevalences with asthma and autism, and effects from fragranced consumer products, Air Qual. Atmos. Health 12 (5) (2019) 519–527.
[30] M.J. Hagström, J.R. Auranen, R. Ekman, Electromagnetic hypersensitive finns: symptoms, perceived sources and treatments, a questionnaire study, Pathophysiology 20 (2) (2013) 117–122.
[31] H. Lai, B.B. Levitt, The roles of intensity, exposure duration, and modulation on the biological effects of radiofrequency radiation and exposure guidelines, Electromagnet. Biol. Med. 41 (2) (2022) 230–255. Apr.
[32] D. Belpomme, P. Irigaray, Electrohypersensitivity as a newly identified and characterized neurologic pathological disorder: how to diagnose, treat, and prevent it, Int. J. Mol. Sci. 21 (2020) 1915.
[33] Y. Stein, I.G. Udasin, Electromagnetic hypersensitivity (EHS, microwave syndrome) – review of mechanisms, Environ. Res. 186 (2020) 109445.
[34] Explaining "Unexplained Illnesses", Disease paradigm for chronic fatigue syndrome, multiple chemical sensitivity, fibromyalgia, post-traumatic stress disorder, gulf war syndrome, and others, Harrington Park Press, New York, 2007 by Martin L. Pall, PhD.

[35] M.L. Pall, Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects, J. Cell. Mol. Med. 17 (8) (2013) 958–965. Aug.
[36] J. Molot, M. Sears, L.M. Marshall, R.I. Bray, Neurological susceptibility to environmental exposures: pathophysiological mechanisms in neurodegeneration and multiple chemical sensitivity, Rev. Environ. Health 37 (4) (2022) 509–530, 2022.
[37] International commission on biological effects of EMF on EHS electromagnetic hypersensitivity (EHS) is a humanitarian crisis that requires an urgent response. (Issued July 2024; Revised August 2024) https://icbe-emf.org/wp-content/uploads/2024/08/EHS-statement-ICBE-EMF-24-08-12.pdf.