

# Non-Ionizing Radiation

---

Non-ionizing radiation (NIR) refers to electromagnetic fields (EMF) that range from low frequencies (LF) to ultraviolet (UV) frequencies. This radiation is not powerful enough to change the structure of atoms or molecules through ionization.

NIR may have a biological effect via other mechanisms. Tissue heating is a proven and well-known effect of NIR, primarily within the range of radio frequencies (RF). In most personal devices that emit NIR, however, the heating effect does not pose a risk of significant damage due to their low output power (as in wireless telephones, Wi-Fi, and Bluetooth) or sufficient protection from the source of radiation (as in microwave ovens). Public discussion of the topic focuses mainly on the non-thermal effects of NIR, which involve a different mechanism through which a magnetic or electric field operates, or which involve another characteristic of radiation that affects the living body.

Studies examining the effects of NIR exposure on human health, particularly its carcinogenicity, have yet to determine whether exposure to NIR causes non-thermal adverse health effects. In 2001, the World Health Organization (WHO) determined that NIR at extremely low frequencies (ELF) is possibly carcinogenic,<sup>1</sup> and in 2011 added RF to this classification.<sup>2</sup> Most countries, including Israel, have adopted the precautionary principle, which calls for measures in cases of potential risk even if the causal association between exposure and a harmful effect has not been proven. Exposure thresholds in Israel are ten times stricter than those established by the WHO.

Researchers have examined the possible association between NIR exposure in a range of frequencies and health outcomes. In the RF range, for example, effects on fertility (sperm quality), cognitive function, the cardiovascular system, hearing loss, and saliva composition have been investigated. In the LF range, research on the effects on birth outcomes (miscarriages and low birth weight), cognitive functions, heart diseases, and neurodegenerative diseases has been conducted. The results of these studies are equivocal.

### Progress since 2017

The *Environmental Health in Israel 2017* report defined challenges related to Non-Ionizing Radiation. Progress achieved in this area during the past three years is outlined below.

#### The challenge: Monitor devices emitting non-ionizing radiation (such as transformers and power lines) in public spaces

**In short:** Continuous monitoring of radiation from 4G cellular transmission sites was expanded.

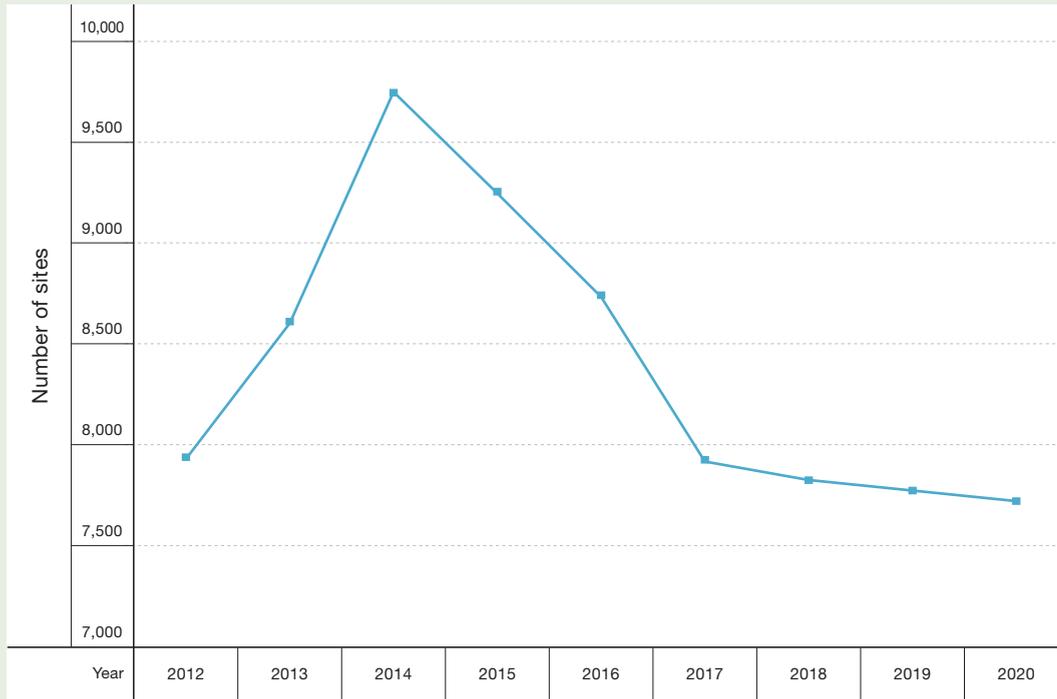
**Challenge for the coming years:** Adopt measures to reduce exposure to radiation, such as promoting the use of wired communication and developing and implementing technological tools to transfer data more efficiently.

The Non-Ionizing Radiation Law of 2006 authorizes the Ministry of Environmental Protection (MoEP) to issue licenses and supervise and enforce restrictions on devices that emit NIR, including transmission sites operated by cellular companies. In this capacity, MoEP regularly monitors the level of radiation produced by cellular transmission sites. Its surveillance system monitors the activity of about 60,000 antennas and checks them for compliance with the transmission power levels stipulated in their licenses. Currently, the system that examines 3G antennas has been expanded to monitor 4G transmission sites (Long Term Evolution [LTE] technology).

MoEP, with support from the Ministry of Communication, initiated a regulatory policy of sharing cellular sites that caused the number of active transmission sites in Israel to decline steadily by 20% from 2014 to 2020. Cellular coverage also improved as the sites enlarged their capacity for serving a large number of users simultaneously (Figure 1).<sup>3</sup> In addition, the levels of exposure to radiation around these sites rose by only about 50% from 2013 to 2019, while the amount of data transferred via the cellular networks increased by a factor of 14.5 (Figure 2).

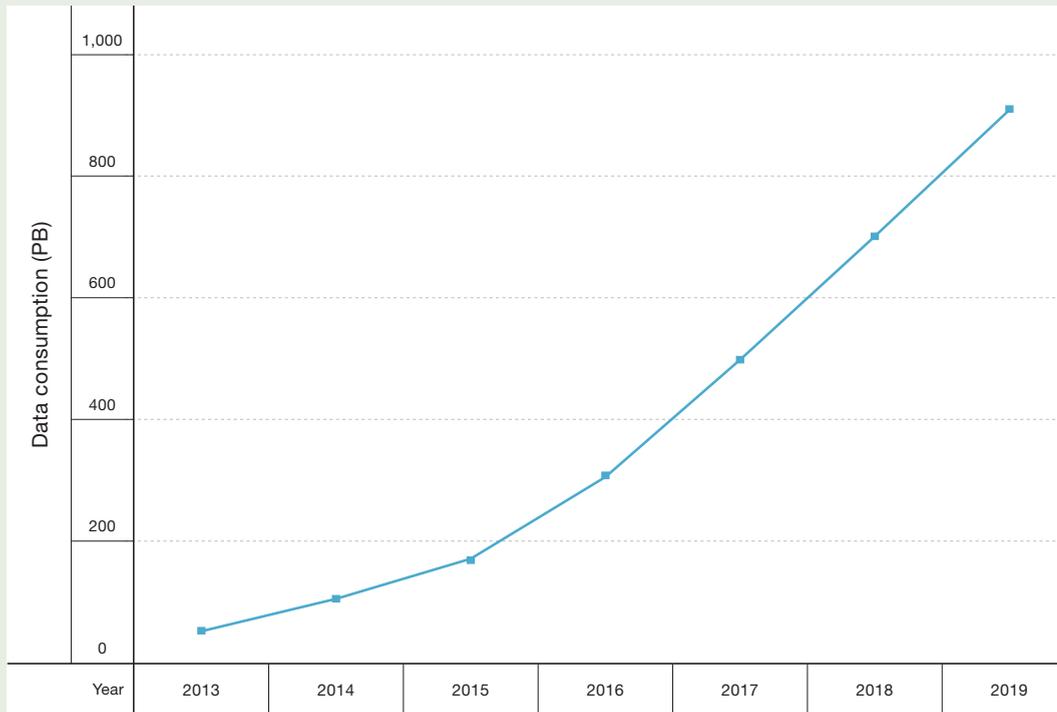
**Legend:** ■ Significant progress ■ Some progress ■ Little or no progress

### Cellular Transmission Sites in Israel, 2012–2020



←  
**Figure 1**  
 Kneset Research and Information Center;<sup>3</sup>  
 Israel Ministry of Environmental Protection

### Data Consumption over Cellular Networks in Israel, 2013–2019



←  
**Figure 2**  
 Israel Ministry of Environmental Protection

**The challenge: Re-evaluate standards in light of new findings regarding health outcomes of exposure to non-ionizing radiation**

**In short:** Current studies, worldwide and in Israel, have not yet been able to establish an association between exposure to NIR and adverse health outcomes. Therefore, at this stage, re-evaluation of the current standards is not justified.

**Challenge for the coming years:** Conduct multidisciplinary research in Israel and maintain involvement in international studies that will serve as a basis for risk assessment.

The possible association between NIR exposure and adverse health outcomes has been studied for many years; the scientific evidence, however, indicates that this association has yet to be established.

In March 2020, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) updated its guidelines on limiting exposure to EMF in the RF range of 100 kHz–300 GHz. The threshold values for cellular frequencies and Wi-Fi were not revised. Importantly, the recommendations on exposure limits pertain only to thermal effects (i.e., proven effects). According to the ICNIRP, thresholds cannot be set in the absence of proven scientific evidence; therefore, long-term non-thermal effects are not taken into account.

In October 2019, the Institute of Electrical and Electronics Engineers (IEEE) issued a new international safety standard for human exposure to NIR in the 0 Hz–300 GHz frequency range. The standard updated the levels of exposure in accordance with new physical models that provide a more accurate assessment of the effect of environmental exposure to EMF on the human body. The update did not revise existing standards for exposure to power frequency fields (50Hz), current generation cellular frequencies, and Wi-Fi frequencies.

Notably, with regard to the public’s exposure, MoEP adopted the ICNIRP’s restrictions on exposure to NIR but added strictures of its own. The threshold for exposure to radiation from broadcasting sites, for example, should not exceed 10% of the exposure level determined in the ICNIRP recommendations for areas where people spend prolonged periods of time, such as residential areas and offices, and no more than 30% of the exposure level determined in the ICNIRP recommendations for areas where people spend short periods of time, such as sidewalks and roads.

**The challenge: Increase public awareness of the potential adverse health outcomes of non-ionizing radiation, the need to reduce exposure, and the potential risks from exposure**

**In short:** The Israeli National Information Center for Non-Ionizing Radiation (TNUDA) published updated recommendations for educated use of cell phones, including by toddlers and children.

**Challenge for the coming years:** Continue working to raise public awareness of the potential adverse health outcomes, and guide the public on educated use of technology involving NIR.

In 2019, TNUDA updated and expanded its recommendations for the educated use of cell phones, including by toddlers and children, in view of the time that had elapsed since the Ministry of

Health (MoH) published its recommendations (2008), the increase in the public's use of devices that emit RF radiation, and changes in technology and use patterns.<sup>4</sup> For this purpose, TNUDA conducted an extensive survey of the latest recommendations for educated use of cell phones in various countries. The updated recommendations include revisions of existing guidelines and new guidelines. For example, it is preferable to send a text message instead of making a phone call and the phone should be kept at a distance from the body during a prolonged transmission. Recommendations on reducing exposure to radiation are organized under three guiding principles: distance from the body, duration of exposure, and power of transmission. The objective is to convey the recommendations to the public in the simplest way so that they will be widely understood and assimilated. The recommendations also relate to distraction while driving and sleep hygiene (healthy sleeping habits and patterns conducive to falling asleep, staying asleep, sleep quality and quantity, and sleep environment, especially among children).

### The challenge: Establish mandatory regulations regarding permissible levels of non-ionizing radiation

**In short:** The stakeholders have yet to reach an agreement and no standards have been legislated.

**Challenge for the coming years:** Reach agreement among all stakeholders on maximum permitted levels and establish them in law.

The 2006 Non-Ionizing Radiation Law is designed to protect the public from effects of exposure to NIR and includes directives relating to the installation and operation of radiation-emitting sources. In 2011, MoEP and MoH formulated joint recommendations that set maximum levels of 2,000 mG for momentary exposure and 4 mG for continuous and prolonged exposure. The recommendations, however, were never translated into legally binding regulations. In 2015, an NGO, the Public Council for the Prevention of Noise and Air Pollution in Israel (Malraz), petitioned the Supreme Court to instruct MoEP to correct this. As of August 2020, the case is still pending in court.

## Research on Exposure to Non-Ionizing Radiation in Israel

- Within the framework of the international INTEROCC study, researchers in seven countries, including Israel, examined occupational exposure to EMF and subsequent health outcomes, including the development of brain tumors. The results did not show an increased risk of developing malignant or benign brain tumors due to occupational exposure to EMF. However, an indication of increased risk of developing glioma (and less so meningioma) was observed at the highest exposure level (upper percentile) of RF when the exposure occurred in the four years preceding the disease. Notably, even in this large study (3,978 patients with brain tumors and 5,601 healthy people who served as a control group), few were exposed to EMF at the workplace: about 10% exposed to EMF in the RF range at their workplaces and around 1% exposed to intermediate frequency (IF) fields.<sup>5</sup> Therefore, the strength of the study is limited.

- ♦ The international MOBI-Kids study, launched in 2009 and involving sixteen research centers including an Israeli research team, examined the association between cell phone use and the risk of developing brain tumors in children and adolescents. At the present writing, the researchers have processed the data and are writing a summary report and scientific articles. Within the framework of the study, the Israeli research team was also asked to investigate a possible association between mothers' exposure to NIR during pregnancy and childbirth (including exposure to ELF radiation during pregnancy—for example, from using an electric blanket) and newborns' risk of developing brain tumors in childhood and adolescence.
- ♦ Researchers from the Gertner Institute for Epidemiology and Health Policy Research are examining the possible effects of fetal exposure to MRI on neurodevelopmental, behavioral, and hearing outcomes in childhood. This innovative study compares the results of tests that examine developmental and behavioral disorders such as ADHD among children who were exposed prenatally to MRI, with those of an individually matched unexposed group. The research results will contribute to the limited knowledge on the safety of MRI tests and will help to establish guidelines for the safe use of MRI as a diagnostic tool.
- ♦ Another study underway at the Gertner Institute on the long-term health effects of MRI investigates the possibility of a carcinogenic effect of exposing children and adolescents to MRI. This study, based on data from Clalit Health Services, examines a possible association between the exposure of children up to age seventeen to MRI and the development of cancer—particularly malignancies of the brain, the circulatory system, and the lymphatic system. In this case-control study, cancer incidence rates among a group of individuals who underwent MRI examination in childhood were compared with those of a control group of unexposed children who were matched for sex and age.
- ♦ Researchers from the Soreq Nuclear Research Center conducted a study in which detailed measurements of power frequency magnetic fields were taken at 222 computer workstations in twelve computer classrooms in three schools. The background levels before the computers were turned on were very low in nine of the classrooms (median and mean smaller than 0.25 mG) and slightly higher in the other three (0.7–1.2 mG). Connecting the computers to the network and operating them had a negligible impact in ten classrooms (<-0.1 mG), raised the median level by 0.2 mG in one classroom, and by 0.7 mG in another. In the overwhelming majority of measurements, field strength was homogeneous in all parts of the body (legs, chest, hands, and head).
- ♦ Another study by researchers from Soreq Center measured adolescents' levels of exposure to power frequency magnetic fields. In this study, eighty-four students in grades 6–10 had a meter attached to their body that measured the magnetic field every 1.5 seconds for twenty-four hours. The students also kept a journal documenting their whereabouts. The study yielded copious statistical data on the participants' exposure: 0.59 mG geometric mean of average daily exposure, 0.73 mG arithmetic mean, and 1–15 minutes spent at levels above 4 mG. The average daily exposure of three participants (3.6%) was measured at more than 2 mG. The lowest exposures were measured while the students were at home (0.3 mG geometric mean). The findings are comparable to those in other countries.<sup>6</sup>

- Researchers from the Technion Faculty of Education in Science and Technology examined the public's understanding and perceptions of NIR-related risks, focusing on parents' perceptions of Wi-Fi radiation in schools. The study, comprised of an analysis of media discourse, social media discussions, and in-depth interviews with sixty-seven parents of children in primary schools, found that 70% of published articles and news items on this subject expressed the view that NIR is dangerous, 52% of comments on social media expressed the same view, and 27% of social media comments expressed an opposing view. The parents who were interviewed agreed to introduce Wi-Fi into the school for various reasons. Although some expressed concern about radiation risks, they considered it pointless to object to Wi-Fi exposure because their children were already exposed to radiation elsewhere.<sup>7</sup>

## Future Challenges

---

Many countries, including Israel, have designated the next generation of cellular communications—the fifth generation (5G)—as a target for technological advancement and implementation. The volume of data consumed via cellular communication is rising steadily every year, thus increasing the level of exposure to radiation. MoEP expects this volume to increase by some 50% per year. There are two main ways to mitigate or prevent the increase in exposure to radiation: 1) build more transmission sites; 2) use new technologies that allow data to be transferred faster and more efficiently. In MoEP's assessment, the introduction and full deployment of these new technologies will result in greater uniformity of NIR exposure from cellular sites. By increasing the number of sites and expanding their deployment within buildings, exposure to radiation from personal cellular devices can be reduced because the devices will require less effort to communicate with the transmission source (and expend less transmission power). However, the increase in use of mobile devices may increase transmission power. Furthermore, the greater efficiency of the technology will allow data to be transferred at a higher rate with better use of transmission power, thus shortening the duration and strength of NIR exposure. The 5G technology uses massive MIMO antennas that enable transmission in a narrow and precise beam that focuses on end devices. Antennas that use earlier technology transmit a broad beam that exposes wider areas to radiation—unnecessarily. The high energy efficiency of the MIMO antennas reduces the exposure to radiation significantly.

It is difficult to assess the health effects of exposure to 5G radiation, for several reasons:

- Scientific knowledge on the health implications of exposure to radiation in this RF range is equivocal and the existence of potential adverse non-thermal health effects is disputed.
- The 5G technology will operate near the frequencies of current generations as well as frequencies that are higher by a factor of ten or more (in the range of millimeter waves). This technology is not yet in use; therefore, the public has not been exposed to radiation in this range of frequencies and few studies have looked into the implications of exposure to millimeter waves on human health. Further studies in the field (under laboratory conditions and among populations) are required.

There is a need to collect data and track the accumulated knowledge on exposure from multiple radiation sources. Furthermore, the publication of health research should be monitored in order to update existing standards as this technology is implemented.

The use of LED lighting in Israel and in the world is expanding because of the advantages it offers, including energy savings and a reduction in air pollution. In recent years, however, some concern has arisen that the use of LED lighting, especially in exposure to its blue light component, may have adverse effects such as disrupting metabolism and circadian rhythms and causing damage to the skin and eyes. Expanding scientific knowledge on these potential adverse effects would give policymakers a basis for decision-making.

In addition to concern about exposure to NIR, parents, educators, health experts, and researchers in Israel and abroad are increasingly worried about the possible adverse health effects of the use of digital media by children and adolescents, such as poor nutritional habits and obesity, headaches and backaches, impaired vision and eye diseases, sleep disturbances, depression, and anxiety. The scientific literature on the health implications of prolonged screen time indicates that the scientific knowledge is not yet sufficiently established.<sup>8</sup> To address this concern, some countries (including Israel) and health organizations<sup>9–12</sup> have recommended limiting screen time exposure for small children, while others have refrained from defining hour limits due to the scientific uncertainty that surrounds the matter.<sup>13, 14</sup> Given the increasing use of screens and growing health concerns related to them, additional research is needed in order to establish a scientific basis for recommendations.

## References

---

- (1) World Health Organization, International Agency for Research on Cancer (2002). *Non-ionizing radiation, part 1: Static and Extremely Low-Frequency (ELF) electric and magnetic fields. IARC monographs on the evaluation of carcinogenic risks to humans, volume 80.* <https://publications.iarc.fr/Book-And-Report-Series/Iarc-Monographs-On-The-Identification-Of-Carcinogenic-Hazards-To-Humans/Non-ionizing-Radiation-Part-1-Static-And-Extremely-Low-frequency-ELF-Electric-And-Magnetic-Fields-2002> (retrieved April 2020).
- (2) World Health Organization, International Agency for Research on Cancer (2011). *Press release no 208: IARC classifies radiofrequency electromagnetic fields as possibly carcinogenic to humans.* [https://www.iarc.fr/wp-content/uploads/2018/07/pr208\\_E.pdf](https://www.iarc.fr/wp-content/uploads/2018/07/pr208_E.pdf) (retrieved April 2020).
- (3) Knesset Research and Information Center (2018). *Cellular antenna infrastructure in Israel—update* (Hebrew). [https://fs.knesset.gov.il/globaldocs/MMM/f9cb6b39-4ac6-e811-80e1-00155d0a98a9/2\\_f9cb6b39-4ac6-e811-80e1-00155d0a98a9\\_11\\_10798.pdf](https://fs.knesset.gov.il/globaldocs/MMM/f9cb6b39-4ac6-e811-80e1-00155d0a98a9/2_f9cb6b39-4ac6-e811-80e1-00155d0a98a9_11_10798.pdf) (retrieved June 2020).

- (4) TNUDA (updated June 2019). Full recommendations for educated use of cellphones. <https://www.tnuda.org.il/en/tips-publications/full-recommendations-educated-use-cellphones> (retrieved April 2020).
- (5) McElvenny, D. M., van Tongeren, M., Turner, M. C., Benke, G., Figuerola, J., Fleming, S., ... Cardis, E. (2018). The INTEROCC case-control study: Risk of meningioma and occupational exposure to selected combustion products, dusts and other chemical agents. *Occupational and Environmental Medicine*, 75(1), 12–22. <http://dx.doi.org/10.1136/oemed-2016-104280>
- (6) Eliyahu, I., Hareuveny, R., Riven, M., Kandel, S., & Kheifets, L. (2017). 24-h personal monitoring of exposure to Power Frequency Magnetic Fields in adolescents - Results of a National Survey. *Environmental Research*, 158, 295–300. <https://doi.org/10.1016/j.envres.2017.06.027>
- (7) Dalyot, K., Sharon, A. J., Orr, D., Barel Ben-David, Y., & Baram-Tsabari, A. (2019). Public engagement with science in everyday life: Perceptions of Wi-Fi radiation risks in schools. *Research in Science Education*, 135. <https://doi.org/10.1007/s11165-019-09894-w>
- (8) Organisation for Economic Co-operation and Development (2019). *OECD education working papers, no. 195. Impacts of technology use on children: Exploring literature on the brain, cognition and well-being*. <https://doi.org/10.1787/8296464e-en> (retrieved April 2020).
- (9) American Academy of Pediatrics, Council on Communications and Media (2016). Media and young minds. *Pediatrics*, 138(5), e20162591. <https://doi.org/10.1542/peds.2016-2591>
- (10) Canadian Paediatric Society, Digital Health Task Force (2019). Digital media: Promoting healthy screen use in school-aged children and adolescents. *Paediatrics & Child Health*, 24(6), 402–408. <https://doi.org/10.1093/pch/pxz095>
- (11) World Health Organization (2019). *Guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age*. <https://apps.who.int/iris/bitstream/handle/10665/311664/9789241550536-%20eng.pdf?sequence=1&isAllowed=y> (retrieved April 2020).
- (12) Israel Medical Association, Institute for Quality in Medicine (2020). *Position paper: Exposure to screens and children's health* (Hebrew). [https://www.ima.org.il/userfiles/image/Ne144\\_kidsAndScreens.pdf](https://www.ima.org.il/userfiles/image/Ne144_kidsAndScreens.pdf) (retrieved April 2020).
- (13) Royal College of Paediatrics and Child Health (2019). *The health impacts of screen time: A guide for clinicians and parents*. [https://www.rcpch.ac.uk/sites/default/files/2018-12/rcpch\\_screen\\_time\\_guide\\_-\\_final.pdf](https://www.rcpch.ac.uk/sites/default/files/2018-12/rcpch_screen_time_guide_-_final.pdf) (retrieved April 2020).
- (14) United Kingdom Department of Health and Social Care, Office of the Chief Medical Officer (2019). *United Kingdom Chief Medical Officers' commentary on 'Screen-based activities and children and young people's mental health and psychosocial wellbeing: A systematic map of reviews'*. [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/777026/UK\\_CMO\\_commentary\\_on\\_screentime\\_and\\_social\\_media\\_map\\_of\\_reviews.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/777026/UK_CMO_commentary_on_screentime_and_social_media_map_of_reviews.pdf) (retrieved April 2020).