

# THE CURSE OF 5G TECHNOLOGY IN THE 21<sup>ST</sup> CENTURY: DRIVING ECONOMIC PROSPERITY AND ADVANCEMENT IN PERSONALISED HEALTH CARE THROUGH THE DESTRUCTION OF HUMANITY

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## ABSTRACT

5G technology is a higher frequency technology that is set to be a predecessor of the 4G network and bring about a transformative ecosystem. Expected benefits are to be in economic growth as the 5G technology is expected to contribute to the incomes of the mobile networks and their associated value chains. The smart technology narrative is set to bring about economic prosperity and also help the health system by way of personalized monitoring methods for remote patients and occupational flow by better storage of patients' digital data and patient consultations. However, these benefits may be short lived as this high frequency technology will come with massive radiation from the closely erected antennas which will have adverse biological, physiological and psychological health effects which will lead to advanced skin, eyes, heart problems, respiratory diseases, poor child development and compromised immune systems for humanity. It is the aim of this paper to review literature highlighting these health effects, this will enable policymakers, scientists and the end users to make informed decisions on whether to allow the full deployment of the 5G network in their nations or not. Recommendations from this paper are, for the world to have an independent board that conducts comprehensive studies on the long run effects of high frequency radiation on humans by carrying out real life experiments.

**Keywords:** - *5G Technology, Economic Growth, Health*

## INTRODUCTION

Globally, wireless communications have been expanding at an exponential rate, with the latest imbedded version of mobile networking technology being called 4G (fourth generation), and the next version 5G (fifth generation) now in its early implementation stages. Due to the coronavirus, plans to fully implement it by end of 2020 have been disrupted but remain at an advanced stage as some “pre 5G” deployment had already started in 2018 (Russel et al., 2018). The 21<sup>st</sup> century has sprung out to be an era that relies heavily on technology; cellphones to laptops have now become an essential part of our work and lives as well. High tech giants have advertised 5G technology as a much faster and more reliable mobile broadband that is offering a richer experience to consumers. Its adoption promises to give the world a transformative communication network with a blast of speed, larger volumes of data and numerous devices with unlimited computing abilities that are conducted instantly to anyone in the world. High tech companies have and are still marketing the Internet of Things to businesses, healthcare systems, industries, schools and the general citizenry. With an obligation to connect our phones and appliances, high tech companies wish to virtually eliminate many day-to-day household and business functions including long distance driving, garbage collection and goods delivery. This is expected to produce a superior, connected society and extraordinary economic growth.

On the scientific angle, it is important to note that all generations of mobile phones use what is called electromagnetic energy. The definite type of electromagnetic energy used by mobile phones is known as Globbally’s radio frequency, which in other texts may be referred to as radio waves or millimeter radio waves (MMW). According to Bushberg et al. (2020), this type of radiation is non-ionizing, thus it does not damage our DNA unlike ionizing radiation. Examples of ionizing radiation include that radiation that comes from the sun or x-rays. Ionizing means there’s enough energy to remove electrons from the atoms they are attached to (Moskowitz, 2018). Electrons will in turn be made unstable and this is something researchers have found non-ionizing radiation used by mobile phones lacking the power to do. To begin with, 5G will use the same type of radio waves as used in 4G, however with time and in the future, it will operate at higher frequencies. This is so as higher frequencies permit for faster connections and response times, while also snow-balling the capacity for more operators to be connected. To note is that, the higher the frequency, the shorter the distance the radio waves travel hence there will be great need for a lot more mobile phone bases and infrastructure will lead to widespread exposure to radio-frequency radiation (RFR) including in public spaces.

What is missing and alarming is that in their research and advertising these High-tech giants are not furnishing the general public with information on the adverse biological, physiological, and psychological health effects of the 2G, 3G, and 4G radio-frequencies we are already exposed to. Furthermore, even in the launching of the 5G, there have not been any explicit warnings from the scientific literature that 5G frequencies could also be seriously hazardous and life threatening. Effort should have been seen in trying to better educate the public of these frequencies especially in the future where higher frequencies will be adopted, minimal effects should be at least reported on and measures to deal with them communicated.

To the world at large, thus including continents like Africa that have not fully adopted the 5G technology but are net importers of manufactured radio-active devices, many important questions arise and they still remain unanswered. Concerns are on the safety of human kind after exposure

to these widespread higher frequencies in our cities and on our homes. The CDC in 2017, poised a point where they asked whether or not adoption of the 5G technology will add to the burden of chronic diseases that already cost nations. Weng et al. (2012) asks a question: “are we not already digitally over connected, shrinking our gray matter and becoming a dysfunctional addicted nation because of it?” Other general concerns are whether our privacy will be affected, especially private medical records. Will physicians in the long run be able to recognize the evolving adverse health effects of new millimeter technology and its current wireless devices? These important questions are yet to be addressed, yet the many national administrators have come up with legislations that have allowed the High-tech industry to move forward with advertising, manufacturing and the adoption of these new technologies. It is the aim of this paper to give an overview on the medical and biological studies that have been done to date that are pointing out the effects from wireless radiation.

## **WIRELESS TECHNOLOGY OVERVIEW**

It is no secret that humankind is always on a mission to develop itself and come up with innovative ideas that allow it to live a comfortable life on earth. Business wise suppliers and manufacturers of vast products are aiming to remain competitive and are always eager and ready to adopt innovations that fulfill their customer demands. Technology has gotten endless advances in innovation throughout the years, for instance in the wireless sector, 1G innovation presented to us the cell phones. 2G made it possible to send information across cell phones, 3G innovation brought us to the portable web and 4G made the web quicker. This has motivated telecom transporters to make progress towards 5G wireless networks that will redefine the highspeed wireless communications on the globe.

### **(A) THIRD GENERATION (3G) TECHNOLOGY**

This generation first came to the face of the earth in 1998, where it was pre-industrially propelled in Japan by NTT DoCoMo for testing purposes. In 2001 3G was propelled economically on W-CDMA standard which depends on GSM. The maximum speed of 3G was evaluated to associate with was 2 Mbps for immobile gadgets and 384 Kbps in moving vehicles, (Naik and Goel, 2020). With 3G cell phones were empowered and they managed to give quicker correspondence by way of being able to send and receive huge messages, give quick web perusing and flowing video driving.

### **(B) FOURTH GENERATION (4G) TECHNOLOGY**

Around 2010 the world was introduced to 3G's predecessor, the cutting edge 4G. It was classified as 4G and 4G LTE; it has speeds quicker than 3G and has a transmission capacity of up to 200 megabits. With 4G there were now shockingly better qualities for voice calls as the information transmitted in the unadulterated packet form because of Orthogonal Frequency Division Multiple Access (OFDMA) multiplexing technique, (Naik and Goel, 2020). 4G delivers HD quality video calls, has the ability to remotely coordinate with better quality and internet gaming streams. After 4G, 4G LTE (Long Term Evolution) was familiarized and it exists as a redesign of the 3G network's architecture for further reducing the network dormancy issues, (Naik and Goel, 2020). The extension of 4GLTE is the 4G VOLTE (Voice Over Long-Term Evolution) it now fully digitizes voice telephony in packet form from circuit switched technology, (Naik and Goel, 2020).

### **(C) 5 G TECHNOLOGY AND HOW IT DIFFERS FROM 3G AND 4G**

5G is not simply an extension or predecessor of 3G and 4G, but a transformative ecosystem that comprises of a heterogeneous network that integrates 4G, millimeter wave, Wi-Fi and various other wireless access technologies. 5G network will connect Internet of Things (IoT) with a variety of speed and data volume requirements hence making them easily accessible and interactive as well. The 5G arrangement recommends to include frequencies in the microwave range in the low-(0.6 GHz – 3.7 GHz), mid-(3.7GHz – 24 GHz), and high-band frequencies (24 GHz and higher) for quicker interchanges, (West, 2016).

This will proceed to guarantee relentless availability of network for mission-specific and possibly life-saving appliances and applications. 5G guarantees to give inevitable network in all spheres of the earth, thus in the most remote regions of the world. This varies from land, air and sea, 5G will be noticeable all around, thus making it clear why it will be a transformation ecosystem rather than a development. In an interview in 2016 with Asha Keddy, Vice President in the Platform Engineering Group, Darrel West (2016) was told that “There was more to 5G, than the G. It is much more transformative. It is much more transformative. With 5G, there will be movement from a user centric world to one of a gigantic machine type of communications where the network will change from enabling millions to billions of devices—an era that will connect these devices intelligently and usher in the modification of information and intelligence.” To note is that 5G is an end-to-end system and it will be able to shift communications to a computing platform. According to West, D (2016), 5G is seen as a representee of an evolution from a point-to-point system to one that senses data from billions of devices and it works to move those communication packets seamlessly to the right device, while using the appropriate processing platform. Four major factors distinguish 5G from its predecessors thus, (a) connected devices, (b) fast and intelligent networks, (c) back-end services, and (d) extremely low latency. These qualities will enable a fully connected and collaborating world with a variety of applications. This will include enhanced mobile broadband, machine-to-machine communications, artificial intelligence, advanced digital services.

## **5G TECHNOLOGY AS A DRIVER OF ECONOMIC GROWTH**

According to Brendan O’Neil, (2017) the 5G technology will usher in new service opportunities for mobile network operators (MNOs) and their value chain. From this we see that 5G will act as a catalytic agent that turns the mobile network industry into a robust and pervasive platform. New business models will in turn transform economies around the globe. 5G technology will be responsible for the heightening of the mobile broadband experience. Brendan O’Neil, (2017) also evaluated three facets of probable economic contribution of 5G to the global economy by 2035. The assumption for these three facets is the regulatory environment is favorable to growth and allow massive deployment of 5G. The first, is the potential increase in sales of products and services that come with the use of 5G across a broad spectrum of industries. Second, a lively 5G value chain will come with continued Research and Development efforts, investments in infrastructure and application development. Finally, 5G holds the potential to drive long-term and sustainable GDP growth (the ultimate gauge of healthy economic progress)

Bill Morelli (2017) also found out that the emergence of 5G signals will enable new classes of advanced applications, fostering of business innovation, and economic growth. The update concluded that, by 2035, 5G if given a chance, will stimulate global sales amounting to US\$12.3 trillion across a broad spectrum of industries. 5G will also support a global value chain

ecosystem that is at the moment generating US\$3.5 trillion in output. With 5G, 22 million jobs are to be supported and created and will make long-term sustainable contributions to the global GDP.

To note is that 5G will bring above the Smart narrative that will boost economic growth, there will be smart mining, smart agriculture, smart manufacturing, smart tourism, smart infrastructure, smart education, smart transport networks, smart real estate, smart workmanship and smart health (just to name a few) which will all add to the boosting and robustness of the 5G value-chain and in turn lead to economic growth. As highlighted earlier in this paper, due to the highly competitive markets, corporates will always aim to gain business advantages at any cost. In turn they will be forced to digitize and automate business processes to increase cost-efficiency and increase their profits. However, by adding autonomous agents to these business procedures, the transaction costs and risks of doing business also increases. A possible solution to handle these risks is that each agent has to communicate directly with each other, thus the adoption of Massive Internet of Things (MIoT)

## **5G TECHNOLOGY AS A DRIVER OF HEALTH ADVANCEMENTS**

5G technology is said to come with smart benefits or the massive internet of things (MIoT) this includes smart agriculture, efficient asset tracking, smart cities and also smart health care. Healthcare has proved to be one of the most indispensable aspect for the overall development of any nation on earth. In some avenues it may be considered as an indication of a society's general well-being. As we are in the 21<sup>st</sup> century it has been characterized by an exponential increase in population (due to better child bearing methods) and this has led to an increased weight on modern healthcare systems. Aparna et al (2020), Akshay Gapchup et al (2020), Islam et al (2020), agree that 5G-enabled MIoT in the health sector will come up as a potential solution to alleviate the pressures on healthcare system. 5G is expected to benefit the likes of Africa which are not entirely accessible and 5G provides a solution through its remote health monitoring initiative. This involves the usage of MIoT sensor devices that quantify and analyze various health parameters of a user remotely. For instance, Baker et al (2017) identified the crucial components of an end-to-end MIoT-based healthcare system for remotely monitoring the health of critically ill patient.

On the hospital set up front, Hathaliya et al. (2019), advocated that with an IoT healthcare system there would be better collection and storage of patients' digital health information. This is seen to enable secure, real-time sharing of medical and treatment histories of patients to certain authorized medical personnel<sup>1</sup>. Ekblaw et al. (2016) proposed a decentralized record management system termed as MedRec to handle private information and manage crucial deliberations such as authentication, confidentiality, accountability, and data sharing. Saravanan et al, (2017) begged to differ and anticipated a healthcare model termed as Secured Mobile Enabled Assisting Device (SMEAD) for diabetes monitoring. It is an end-to-end blockchain-based healthcare system, which is responsible for real-time monitoring of diabetic patients. Moreover, it was based on the notion that wearable devices were not appropriate for emergency situations and were simply used for monitoring purposes. SMEAD assist patients who seek special care and endless supervision from specialized doctors.

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<sup>1</sup> What is an electronic health record (EHR)? URL: <https://www.healthit.gov/faq/what-electronic-health-record-ehr>.

Public opinion studies and surveys in the 1<sup>st</sup> world have found out that that many people are enthusiastic about these kinds of medical devices and services. In fact, a survey of 12,000 adults across eight nations showed that 70% were willing to see a doctor via video conference for non-urgent appointments, (Saravanan et al, 2017). To add on another 70% were receptive to using toilet sensors, prescription bottle sensors, or swallow health monitors into their systems, in addition, the use of 5G technologies has been said to have the potential to safeguard quality, and reduce overall medical costs, (West, D 2016). Costs saved include those like, (a) using sensors and remote monitoring devices that help patients living in isolated areas gain access to top medical assistance, (b) using video conference facilities or telemedicine which will reduce the geographic divide and bring high quality care to underserved communities and (c) point-of-care testing (POCT) which will save money by avoiding costly hospital visits, this will be better than going to a large medical facility, patients will take advantage of m-health technologies and digital platforms.

So, with the above one may see that patients have largely been enticed by the benefits they will be getting such as saved medical consultation and travelling costs. History has it they were not informed about the potential endless radiation effects they will incur; this also is the same for the health care personnel hoping to adopt and implement the IoT in healthcare.

### **CURRENT FEDERAL COMMUNICATIONS COMMISSION (FCC) RADIO FREQUENCY GUIDELINES**

The FCC commission is a body responsible for regulating world regulating frequencies. Since its inception in 1996 there has been much talk by current literature on the relevance of the commission's guidelines as they are referred to as outdated compared to the frequency levels current mobiles are conducting and their biological effects. In Physics and Engineering, non-ionizing radiofrequency radiation, which is now used in modern telecommunications today is said to have too little energy unit per photon to move electrons in an atom which causes causing ionization. This is the likely phenomenon seen with radiation from X-rays and radioactive materials (WHO, 1981). Physicists and Engineers argue that heat is the only measure of harm which is meaningful with regards to health and safety of radio-waves.

Proposed fifth generation (5G) technologies will use frequencies between 30 and 100 GHz (FCC GUIDELINE) which are shorter millimeter wavelengths (1–10 mm). Wireless communication uses electromagnetic frequencies to carry data through the air. Classically, this includes both a carrier wave and an operating wave. In order to carry large data at faster speeds, each new generation of telecommunications has to use higher frequency radio waves. The cycle of technology is that, the higher frequencies are added to the existing frequencies of older technology (Chávez-Santiago et al, 2015, 5G Vision EU). This creates a boosted mix of electromagnetic frequency exposures.

In modern digital communications Higher frequency and shorter wavelength radio frequencies (microwaves) are now widely used. 1G to 4G radio frequency wavelengths are centimeters to a meter in width and were first used in military communications decades ago, (Chávez-Santiago et al, 2015). These shorter wavelengths transmit data in an orthodox line of sight path but just for shorter distances. Cell towers thus can transmit dozens of miles away versus typical radio

communication towers that can transmit for 100's of kilometers, depending on the power output, height of the tower, weather and topography.

The new 5G small cells, which have millimeter waves, will only be able to transmit only 300 meters. Due to the advancements in telecommunications, frequencies used now have shorter wavelengths and faster data transfer. Various data channels may be compressed into the shorter frequency bands which enables additional data to be transferred at the same time. This means more data at faster speeds. Older cell phones and cordless phones use 900 and 1800 MHz wavelengths. Today nearly all newer wireless devices use a small range of frequencies clustered near 2.4 GHz for example cell phones, cordless phones, Wi-Fi routers, and Bluetooth. Dejectedly, this has been proved to be the same frequency, residential microwave ovens use but with much less power, hence the guidelines are now being exceeded unknowingly (or maybe “unintentionally”) which is hazardous. The primary objective of this study is to conduct a review on the health effects of 5G technology. We also seek to have a consolidation of literature that will help policy makers in understanding the possible health effects and prevalence of 5G health related ailments. More so, this systematic review will also assist policymakers, scientists, humanitarians and engineers to make informed and evidence-based decisions and policies on the adoption of the 5G technology.

## **RELEVANCE & TIMELINESS OF STUDY**

Industry papers discussing 5G, talk about everything smart, thus smart cities, smart agriculture, smart health and smart working environments. However, there isn't much talk about the physiological, psychological and biological effects of these microwave radiations to human kind, considering they have a high chance of exceeding the FCC guidelines of 6–100 GHz range. Focus is mainly on the benefit this hyper-connecting technology of 5G. However, little knowledge is being shared on the public health concerns. It is the aim of this paper to conduct a thorough investigation on the undocumented health effects of 5G technology in the 21<sup>st</sup> century and possible ways these may be reduced. Regulations concerning cost, access and usage of this widespread internet structure are yet to be determined. Health and psychosocial effects are largely absent from business discussions and this review will unearth some of these from the published literature and expose it to the public and relevant authorities so that they advocate for the implementation of 5G in a considerate manner. Sustainable Development Goal 9 (Industry, Innovation and infrastructure) talks of the need for technological progress which gives out lasting solutions to both the economy and environment. However, it points out that these innovations should instill sustainable development something feared will not be possible with 5G technology as the economy will blossom at the expense of the innovator and general populace's health.

## **METHODOLOGY**

Literature review on health effects of wireless technologies, controversies related to radiofrequency health effects, telecommunications 5G innovations and specifications for wireless technology as well as related policies affecting public health were reviewed. The studies were found by searching for articles published from January 1970 and to November 2020. Titles, abstracts, reference lists and full texts were assessed for inclusion and a search was conducted using combinations of the following terms: 5G technology and health, Effects of 5G on human health, is 5G technology good for public health and Effects of radioactive frequencies Article

sources included Google Scholar, PubMed, ScienceDirect, Toxicology letters and WHO databases. The qualitative approach used is supported by relevant statistics and figures from the official websites of organization like WHO, CDC and the World Bank.

## **DISCUSSION ON THE PSYCHOLOGICAL, PHYSICAL AND BIOLOGICAL EFFECTS OF 5G TECHNOLOGY**

Current and future implementation of the 5G technology will increase the cell tower densities by an order of magnitude. Health apprehensions have been raised about wireless radiation from, mobile communication devices, work-related exposure, residential exposure, wireless networks in homes, and schools, automotive radar, and other non-ionizing radiation sources, such as smart meters and Internet of Things. Russel (2018), found out that Millimeter waves (MMW) were absorbed by water in living plants, bacteria, insects and human skin with variable effects, with the generality being adverse. With this shallow penetration of MMW concern is on the eyes and skin of humans. Further concern is what these waves do within the human body, thus the cardiovascular effects, genetics, fertility, neurological behaviors and the possibility of cancer development. Bacterial effects have also been examined by the authors reviewed and there is evidence of antibiotic resistance caused by MMW. According to Wu et al. (2015a), the penetration depth of MMW in humans exceeds 90% of the transmitted power and is absorbed in the epidermal and dermal layers. With this depth being so superficial, higher heating occurs more quickly with less dissipation. Many biological responses to MMW irradiation can start within the skin (Isaac et al., 2012; Ziskin, 2013).

Pakhomov et al., (1998) highlighted that systemic signaling in the skin may go deep in the body's system to cause physiological effects on the nervous system and the immune system, all this mediated through the neuroendocrine mechanisms. Resultant effects would be, especially in developed nations (net consumers of genetically modified foods), autism, reproductive problems, pregnancy outcomes, blood-brain barrier disruption, pineal gland production, sleep disturbance, headache, irritability, fatigue, concentration difficulties, depression, dizziness, digestive disturbance, tremor, cardiac irregularities among others.

### **(A) SKIN EFFECTS OF 5G TECHNOLOGY**

Several experimental studies have shown that surface effects of low intensity millimeter waves can be quite substantial, inducing a number of biological changes, even at non thermal levels, including cell membrane effects (Feldman et al., 2009; Ramundo-Orlando, 2012; Ziskin, 2009; Feldman et al., 2008; Millenbaugh et al., 2006; Enin et al., 2013; Hayut et al., 2014; Ney and Abdulhalim, 2011; Chernyakov et al., 1989). Feldman et al., (2008; 2009) verified that the sweat ducts in human skin are helically shaped tubes, full of conductive aqueous solution. Their research indicates that sweat ducts in the skin could behave as antennas and thus respond to millimeter waves, other effects include tinnitus, burning and flushed skin.

### **(B) 5G TECHNOLOGY AS A CAUSE OF EYE PROBLEMS**

The lead cause of blindness in the world, are cataracts, and are a societal burden due to their high incidence, cost and consequences to one's quality of life (CDC, 2015). With the implementation of 5G applications the eyes will be receiving significant radiation especially through nearfield exposures. An eight-year study presented the total Medicare costs for cataract surgery alone to be approximately US\$3.6 billion, which amounts to 60% of all eye care costs (Ellwein and



Urato, 2002). Well-known risk factors in the development of cataracts are age, smoking, diabetes, and UVB exposure. Research is pointing towards oxidative damage as a general instrument for age related cataracts (Spector, 1995; Ye et al., 2001; Abraham et al., 2006). Microwave radiation is also a known cause of cataracts with heat being an unquestionable mechanism, this is so as the eyes lack sufficient blood flow to dissipate heat effectively. There is some evidence that repeated low level exposures to microwave radiation could cause cataracts but researchers agree that more studies are needed (Vignal et al., 2009; Riva et al., 2005; Ryzhov et al., Carpenter and Van Ummeren, 1968; Moss et al., 1977; Foster et al., 1986; Van Umersen and Cogan, 1976; 1991; Dreaan et al., 2013; Morgan et al., 2015).

In a study on rats, Prost et al. (1994) was one of the first authors to study the effects of millimeter microwave radiation on the eye. He noted that MMW of different wavelengths had been implicated in the development of cataracts. His research further found that low power millimeter waves formed lens opacity in rats over a 58-day period (10 mW/cm<sup>2</sup>), indicating MMW is a predisposing influence for cataracts. More so, Bormusov et al. (2008) studied the non-thermal effects of high frequency radiation from cell phones and other wireless devices on lens epithelium. The study found both reversible and irreversible ocular changes and it noted that the effects found with short term exposure at low levels could with time translate to similar effects with cataracts over a 10–20year period of cumulative exposure. They recommended that cell phones be used from a distance to minimize exposure and that this reduces any potential harmful effects of cell phone use on the human lens. Wu et al. (2015b), while looking at the health effects of MMW, supported current standards of safety based on heat but pointed out that the MMW research on biological effects is thin relative to that of longer microwave frequencies. Their recommendation was that further studies be done to study the potential biological effects of MMW radiation in order to come up with appropriate consumer guidelines, particularly where antennas are placed close to the body.

From the available literature on effects of 5G technology on eyes, it appears that microwave frequencies have non-thermal biological effects on the lens of the eye. 5G deployment will add shorter wavelengths to longer wavelengths which are yet to be adequately tested for long term exposure. With the probable increase in wearable ocular digital technology, devices such as virtual reality for gaming, the social sciences, entertainment, and healthcare, there will be significantly additional exposure to microwave radiation very close to the eye orbit. Current safety FCC guidelines are based on heat measurements and the scarcity of literature on ocular effects of MMW highlights the want for much more independent research and precaution moving forward to prevent an epidemic of ocular pathology.

### **(C) EFFECTS OF RADIATION ON THE IMMUNE SYSTEM OF HUMANS**

The common narrative offered in the literature and media is that the adverse impacts resulting from high-band 5 G mainly impact near-surface phenomena, such as skin cancer, cataracts, and other skin conditions. However, there is evidence that biological responses to MMW can be initiated within the skin and the successive systemic signaling in the skin can results in physiological effects on the human nervous system, heart, and immune system (Russell, 2018). Lushnikov et al. (2003) investigated cell-mediated immunity and nonspecific inflammatory response in mice exposed, they found that MMW radiation reduced both immune and nonspecific inflammatory responses. Gapeev et al. (2003) presented for the first time that low-intensity extremely high- frequency electromagnetic radiation in vivo causes effects on spatial

organization of chromatin in cells of lymphoid organs. He exposed mice to a single whole-body exposure for 20 min at 42.0 GHz and 0.15 mW/cm<sup>2</sup> and suggested that the effects like excessive reactive oxygen species/oxidative stress and inflammation were due to involvement of the neuroendocrine and central nervous systems.

#### **(D) GENE SUPPRESSION DUE TO MMW RADIATION**

Chen et al. (2008) found an upregulation of some genes in human keratinocytes with MMW exposure at low power density. Habauzit et al. (2014) also looked at gene expression in keratinocytes with 60 GHz exposure at the upper limit of current guidelines, he concluded that the high number of modified genes, repair inhibition and chromatin structure being caused by the exposure experienced. He highlighted that FCC current limit is probably too permissive to prevent biological response.

#### **(E) BACTERIAL ANTIBIOTIC RESISTENCE**

Shcheglov et al. (2002) examined MMW on cells at various cell densities and frequencies, he found out that cell-to-cell communication may be involved in bacterial responses to be weak when exposed to MMW. To note are the works by Isakhanian and Trchunian (2005) who irradiated water and buffer solution with low intensity MMW, they found out that the irradiated water had a bactericidal effect that vanished after recurrent exposure and the buffer solution increased the growth of bacteria. They advocated that this was due to the membranotropic effects. Repeated irradiation reversed the bactericidal effects indicating that a compensatory mechanism was involved in the long run. In another review, an investigation on the mechanisms of bactericidal and antibiotic resistance after exposure to low intensity MMW was done, (Torgomyan and Trchounian 2013). Alterations in water structure, cell membrane or the genome leading to changes in metabolic pathways was said to have accounted for these effects.

#### **(F) NEUROBEHAVIOURAL EFFECTS OF 5G TECHNOLOGY**

Zalyubovskaya (1977) addressed the biological effects of millimeter radiowaves and ran experiments using power fluxes of 10,000,000  $\mu$ W/ square meter (the FCC (Federal Communications Commission) guideline limit for the general public today in the USA), and frequencies on the order of 60 GHz. Not only was skin impacted adversely, but also organs like the heart, liver, kidney, spleen tissue as well, and blood and bone marrow properties. He also found out that exposure to high radio frequencies will lead to cardiovascular related ailments like asthma and breathing problems, especially for the elderly who would have been exposed more to the radiowaves. Other studies that are being done on pregnant women and children still at school who use mobile phones are close to mobile antennas in public space have shown that radio waves have an effect. Studies have been done further to assess the development of the children, their motor skills, spatial working memory, and concentration in school, unfavorable impacts of exposure have been seen.

The discussion above was on how the introduction of the 5G technology will be a public health threat and how it will further increase and contribute to diseases such as brain cancer, neurodegeneration, developmental defects, infertility and electro sensitivity that radiation have induced in the past.

## RECOMMENDATIONS

- i. Substantial empirical research and testing should be done on the potential 5G health effects under real-life environments before further rollout can be acceptable.
- ii. We also recommend that the deployment of 5G be suspended until an independent regulatory and advisory board is developed and extensive research on the biological effects is warranted, along with research on exposure levels of radiofrequency radiation.
- iii. Current FCC safety guidelines are based on heat measurements and there is need to have them focused significantly, on microwave radiation; which is now popularly used.
- iv. There also should be a sound regulatory policy framework for the globe, which determines current and future telecommunications initiative and innovation. These policies should ensure initiatives are carefully assessed and their risks to human health, environmental health, privacy, security and social consequences immensely evaluated before any deployment approvals are done.
- v. Consistent and up to date public health regulations need to always match on going and appropriate research science. Thus, to ensure that if there are potential threats they are seen in advance and deployment halted. Health boards should desist from a responsive approach when coming up with regulations and have set guidelines which are at the disposal of High-tech giant and the public to make informed decisions.
- vi. Dialogue among scientists, governments and the public should be initiated, to help increase understanding of mobile communications and their long-term impacts. This may be done through public hearings and symposiums by high-tech giants on the future of their innovations.
- vii. Legislators are advised to come up with policies which do not limit the truthfulness of science and the scientific community with regards to health and environmental effects of wireless technologies or other toxic exposures. These should be changed to enable unbiased, objective and precautionary science research to drive necessary public policies and regulation.

## CONCLUSION

This paper examined the evolution of the wireless networks and it also went on to highlight the potential benefits of the 5G network to the economy and the healthcare systems. The study went on further to point out how humans are becoming more dependent on technology and speed and how telecommunication companies are bringing-in solutions to meet the demands. 3G, 4G and now 5G technology is booming everywhere in the world. Undoubtedly, 5G will bring-in lots of advancements in our lives in terms of medical care and IoT devices. However, governments have to consider all the negative effects that can affect the human body in the long-run due to 5G technology's MMW and electromagnetic radiations. Few cities around the world have already halted the implementation of 5G because of its ill effects on humans and the environment. The paper went on to discuss on the adverse effects that are being experienced and those to be expected and it came to a conclusion that high-tech companies in their advertising and deployment of 5G network may have "intentionally" "undermined" publications on these potential effects.

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