



An Analytical Study on Radiofrequency (RF) – Electromagnetic Radiation Including 5G and Its Relevance in Causing Attention-deficit/hyperactivity Disorder (ADHD)

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Abstract – As the use of 5G technology grows, there are worries about the possible health risks of being exposed to radiofrequency electromagnetic radiation (RF-EMR). This paper is about the possible risks of 5G radiation causing neurodegeneration, which can lead to more neurodevelopmental disorders like ADHD. MIMO (multiple input, multiple output) antenna arrays, which have a small range at mm-wave frequencies, are used in 5G technology. This means that a large number of MIMO-enabled antenna arrays would need to be set up for 5G to work on its own, putting more people in the area at risk. ADHD is a well-known neurological developmental disorder that affects children, adolescents, and adults. Individuals with ADHD present difficulties in several domains of attention and cognitive functions, including problem-solving, planning, orienting, alerting, cognitive flexibility, sustained attention, response inhibition, and working memory. Research shows that being exposed to RF-EMF can cause a lot of damage to the neurons in the brain. This can lead to changes in memory and learning, which are symptoms of ADHD. Studies have shown that people with ADHD have less activity in a number of frontal regions. This means that there is less activity in the areas that control inhibitory and working memory processes. In line with the new research, it seems that being exposed to high levels of non-ionizing radiation while still in the womb increases the risk of ADHD. Survivors of pediatric brain tumors who are exposed to RF-EMF are also at increased risk for ADHD and related symptoms. Neuroendocrinologists can see that hormones have an effect on how behavior is organized, and more exposure to RF-EMF has been shown to cause changes in hormones. Because of how quickly cells divide and how much oxygen the mitochondria use, testicular tissues are more likely to be damaged by oxidative stress. Researchers have found that when people are exposed to RF-EMF more, their testosterone levels go up and their luteinizing hormone levels go down. High testosterone levels may make ADHD symptoms more likely by delaying the development of dopaminergic innervations and metabolism, lateralizing the underlying dopaminergic neural circuitry, and increasing the reuptake of dopamine neurotransmission. In conclusion, the growing use of 5G technology has made people worry about the possible health risks of RF-EMR exposure, especially when it comes to neurodevelopmental disorders like ADHD. More research needs to be done to fully understand the possible health risks of 5G radiation and come up with ways to reduce those risks.

Keywords: Attention-Deficit/Hyperactivity Disorder (ADHD), 5G, cancer, testosterone, hormones, radiofrequency, dopamine, neurodevelopment.

1. INTRODUCTION



With the growing 5G implementation world-wide, exposure to radiofrequency electromagnetic radiation (RF-EMR) from various wireless devices has increased dramatically with the advancement of technology. As a result, there is a huge gap that must be answered with regard to the health implications on growing children and adults. This paper focuses on the imminent dangers of 5G radiation causing neuro-degeneration. This can lead to increased prevalence of neuro-developmental disorders such as attention-deficit/hyperactivity disorder (ADHD). Other developmental disorders under DSM-V include intellectual disability (ID), autism spectrum disorder (ASD) Communication Disorders, Specific Learning Disorders and Motor Disorders (1,18).

2. OBJECTIVE

The objective of this work is to establish the imminent effects of Radiofrequency Electromagnetic Radiation due to widespread 5G implementation resulting in developmental disorders such as ADHD in children and adults.

3. METHODOLOGY

For the literature retrieval, we used: NCBI PubMed database. Search restrictions were based on the English language, year of publication between 2009 and 2022, type of publication set to journal, and human and rodent experimental models.

We initially started by analyzing reports on large scale 5G implementation, elaborating its key elements, speed of data transfer, frequency range, number of towers to be installed and the area coverage. Moreover, we examined papers involving ADHD caused due to 5G exposure and found it interesting to include substantiating causes such as pediatric tumor and hormonal changes caused by RF exposure. Finally, we connected all pertinent information justifying the main objective of our paper.

4. EXPLORING THE LINK BETWEEN RF-EMF EXPOSURE AND ADHD: PREVALENCE, MECHANISMS, AND RISKS

4.1 Prevalence of 5G in our lives in the near-future

Beyond the existing 4G/IMT-Advanced standards, 5G refers to the next significant stage of mobile telecommunication standards.(2)(Fig.1) One of the key elements of 5G technology include expanded use of MIMO (multiple input, multiple output) antenna arrays. The trade-off for speed at mmWave frequencies is limited range. Testing of the mm Wave 5G service MIMO ranges has shown results of 500 meters or less from the tower, indicating that a massive spread of MIMO-enabled antenna arrays would be needed for pure standalone 5G deployment(3). Thus increasing its exposure amongst nearby dwellers.

4.2 Global prevalence of ADHD

ADHD is one of the most well-known neurological developmental diseases that affects children, adolescents, and even adults.(4) Individuals with ADHD present difficulties in several domains of attention and cognitive functions: problem solving, planning, orienting, alerting, cognitive flexibility, sustained attention, response inhibition, and working memory.(5) The Global prevalence of persistent adult ADHD and symptomatic adult ADHD was 2.58% and 6.76% respectively according to a study in 2020. (6)(Fig.2)

4.3 RF-EMF producing ADHD by neuro-degeneration



Referring to the paper published by Nidhi S, et al (2014), there is significant evidence of extensive neuro-degeneration on exposure to RF-EMF resulting in alterations in behavior related to memory and learning which come under the symptoms of ADHD. (7) Executive function works through a circuit that comprises of the frontal cortex (e.g., lateral prefrontal, premotor, anterior cingulate), dorsal striatum (e.g., caudate), and the cerebellum via thalamic projections. The mainly affected areas under ADHD are lateral inferior frontal regions, corpus striatum and dorsal anterior cingulate. Further study found reduced activation in multiple frontal regions in ADHD adolescents. Together, these findings showing reduced activation in ADHD subjects indicate less engagement of regions mediating inhibitory and working memory processes. (8)

4.4 ADHD caused by in-utero effects of RF-EMF

Consistent with the emerging literature, there was a study suggesting that in-utero exposure to high levels of non-ionizing radiation was associated with an increased risk of ADHD. According to another study conducted among 1454 mother-child pairs (548 white [37.7%], 110 African American [7.6%], 325 Hispanic [22.4%], 376 Asian or Pacific Islander [25.9%], and 95 other or unknown [6.5%]; mean [SD] maternal age, 31.4 [5.4] years), 61 children (4.2%) had physician-diagnosed ADHD. (9)

4.5 Carcinogenicity of RF-EMF leading to ADHD

Radiofrequency electromagnetic fields (RF-EMFs) for communications come under the 30 kHz–300 GHz range (10) The International Agency for Research on Cancer (IARC) at the World Health Organization (WHO) in May 2011 classified RF radiation in the frequency range of 30 kHz to 300 GHz to be a ‘possible’ human carcinogen, Group 2B (11). Survivors of pediatric brain tumors often have neuro-developmental late effects, such as inattention. According to a study, 13.1% of survivors had ADHD diagnoses, 19.9% had symptoms of ADHD without diagnoses, and 12.1% had ADHD medication use. The study concluded that survivors of brain tumors are at increased risk of ADHD and related symptoms. The greatest increase in risk occurs for survivors with diagnoses at younger ages and supra-tentorial tumors. (12)

4.6 RF-EMF producing ADHD through hormonal variations

Hormonal influences on the organization of behavior are apparent to neuro-endocrinologists but under-examined in relation to childhood and adolescent mental disorders. One of the most vulnerable organs to the RF-EMR is the testes. This is due to the fact that testicular tissues are more susceptible to oxidative stress due to a high rate of cell division and mitochondrial oxygen consumption. (13) Increased exposure to RF-EMF showed significantly higher Testosterone and lower Luteinizing Hormone (LH) levels than those who were less exposed (14). A maturational delay in the development of dopaminergic innervations and metabolism, lateralization of underlying dopaminergic neural circuitry as well as an increase in the reuptake of dopamine neurotransmission, are all possible mechanisms by which high testosterone levels may increase the risk for ADHD symptoms. (15)

Gonadal hormones may also act directly on the prenatal development of dopaminergic neural circuitry and dopamine function in the nucleus accumbens, striatum, and prefrontal cortex (PFC) (15). The substantia nigra and ventral tegmental region of the brain release dopamine (DA), a neurotransmitter that primarily affects the prefrontal cortex (PFC). Stimulation by DA enhances the working memory and the attention regulation processes of the PFC. Nonetheless; only a modest amount of secreted DA is required to enhance behaviors, attention and working memory. Very high or very low levels of DA will impair working memory and lead to ADHD symptoms. (16, 17)



We are not newly exposed to RF-EMF, but a widespread 5G implementation will greatly expand the exposure spectrum. So it only makes sense that we recognize its advantages and disadvantages and implement necessary safeguards.

5. CONCLUSION

The exposure to radiofrequency electromagnetic radiation (RF-EMR) from various wireless devices has substantially increased with the expansion of 5G across the globe. As a result, there is a significant question that needs to be addressed in terms of the effects on the health of developing children and adults. This study focused on the impending risks of neuro-degeneration brought on by 5G radiation. A notable number of survivors of pediatric tumors caused by RF exposure experienced late development of ADHD. Testicular tissue damage caused by RF-EMF resulted in increased levels of Testosterone which increased the risk of developing ADHD.

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