

Assessment Of The Impact Of Electromagnetic Radiations From Mobile Phone Towers On Male Sperm Infertility.

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ABSTRACT: The telecommunication sector has witnessed fast growth in the number of mobile telephone users now served by seven cellular operators. Until February 2012, there were about 26 million mobile phone subscribers served by more than 4,000 base stations spread all over the country (Tanzania) and this is due to increase in population. Despite the many advantages brought by services, there is increased public concern over possible adverse health effects due to electromagnetic fields (EMF) radiated by the mobile phone towers. The paper assesses the impact of the electromagnetic radiations from mobile phones towers to male sperm infertility. The electric field from the mobile phone tower placed at a certain distance from testis position were noted and then analysed by considering SAR relation to electric field from the tower to the testis. It was concluded that there is significant impact on the male sperm infertility on the exposure of the male reproductive organ to the radiations from the towers at the specified operating frequencies near the testis. Recommendations has been provided, that mobile phone towers should not be built nearby the area where most people are living as the distance between the two are so small to cause the male sperm infertility which is the long term effect that's why most people don't see that there are effects associated with those radiations.

Keywords : Mobile phone towers, Specific Absorption Rate (SAR), Electromagnetic radiation (EMR), male sperm fertility, sperm count and electric field intensity.

I. INTRODUCTION

Cell phone towers expose the public to involuntary, chronic, cumulative Radio Frequency radiation. Low levels of RFR have been shown to be associated with changes in cell proliferation and DNA damage. Some scientific studies show adverse health effects reported in the .01 to 100 mW/cm² range at levels hundreds, indeed, thousands, of times lower than the U.S. standards. These harmful low levels of radiation can reach as far as a mile away from the cell tower location. Reported health problems include headache, sleep disorders, memory impairment, nosebleeds, an increase in seizures, blood brain barrier leakage problems, increased heart rates, lower sperm counts, and impaired nervous systems.[1] Infertility is defined as inability to conceive after a year of sexual intercourses without the use of contraceptives. In half of the cases the causative factor is the male. Males are exposed to the effect of various environmental factors, which may decrease their reproductive capabilities. A decrease in male fertility is a phenomenon which occurs within years, which may suggest that one of the reasons for the decrease in semen parameters is the effect of the development of techniques in the surrounding environment. A hazardous effect on male fertility may be manifested by a decrease in the amount of sperm cells, disorders in their mobility, as well as structure. The causative agents may be chemical substances, ionizing radiation, stress, as well as electromagnetic waves.[2] Despite the relative importance of infertility due to the male, infertility evaluations have traditionally focused on women, because women tend to seek gynecological care and because men often are reluctant to seek advice. A variety of disorders ranging from hormonal disturbances to physical problems, to psychological problems can cause male infertility. Although many treatment options are now available, in many cases treatment will not work. In many instances, male infertility is caused by testicular damage resulting in an inability of the testicle to produce sperm. Once damaged, the testicle will not usually regain its sperm-making capabilities; this aspect of male infertility is analogous to menopause (though not natural

like menopause) for women and cannot usually be treated. Despite medicine's limited ability to treat male infertility, many successful treatment options are available for its many causes. Besides testicular damage, the main causes of male infertility are low sperm production and poor sperm quality. Radiofrequency (RF) energy is a type of nonionizing radiation, including EMR produced by cellular phone, and is not strong enough to cause ionization of atoms and molecules. Cellular phones emit low levels of RF in the microwave range while being used. Although high levels of RF can produce health effects (by heating tissue), exposure to low-level RF may not produce heating effects and causes no known adverse health effects. Several experimental studies demonstrated that exposure to electromagnetic or static magnetic fields had adverse effects on the reproductive system. [3] In recent times there has been some controversy over the impact of electromagnetic radiation on human health. The significance of mobile phone radiation on male reproduction is a key element of this debate since several studies have suggested a relationship between mobile phone use and sperm quality. The evaluation of the effect of mobile telecommunications on the state of human health is a difficult issue, which results from the fact that there is a problem with isolating from various environmental factors the particular one that may be caused by electromagnetic waves emitted by mobile phones. In addition, waves of the same frequency waves emitted by phones in association with other factors should also be considered. It may be presumed that people who intensively use phones more often perform sedentary work. This is conducive for the elevation of temperature in the region of the scrotum, and infertility. People who talk on the phone, to a greater degree may be exposed to stress, which by affecting the level of cortisol, prolactin and testosterone may contribute to the decrease in the concentration of the semen. [4]

II. GENERAL OVERVIEW

A. MOBILE PHONES TOWER RADIATIONS IN RELATION TO BIOLOGICAL EFFECTS.

When a human body is exposed to the electromagnetic radiation, it absorbs radiation, because human body consists of 70% liquid. It is similar to that of cooking in the microwave oven where the water in the food content is heated first. Microwave absorption effect is much more significant by the body parts which contain more fluid (water, blood, etc.), like the brain which consists of about 90% water. Effect is more pronounced where the movement of the fluid is less, for example, eyes, brain, joints, heart, abdomen, etc. Also, human height is much greater than the wavelength of the cell tower transmitting frequencies, so there will be multiple resonances in the body, which creates localized heating inside the body. This results in boils, drying up of the fluids around eyes, brain, joints, heart, abdomen, etc.[5] Cell tower antennas transmit power in the frequency range of 869 - 894 MHz (CDMA), 935 - 960 MHz (GSM900) and 1810 - 1880 MHz (GSM1800) and 3G is now being deployed in many areas, in which base station antenna transmits in the frequency range of 2110 - 2170 MHz. The base stations are normally configured to transmit different signals into each of different sectors. In general, there may be three sectors with equal angular coverage of 120 degrees in the horizontal direction as this is a convenient way to divide a hexagonal cell. If number of users is distributed unevenly in the surrounding area, then the sectors may be uneven. These base stations are normally connected to directional antennas that are mounted on the roofs of buildings or on free-standing masts. The antennas may have electrical or mechanical down-tilt, so that the signals are directed towards ground level.[5] Several studies have found that not only does using a phone affect a man's sperm quality, but simply having it switched ON in a pocket was enough to do damage as mobile phones periodically but briefly transmit information to cell towers to establish contact. Radiation from cell phone can also produce DNA breaks in sperm cells that can mutate and cause cancer. Damage to sperm DNA increases the risk further and can pass on the genetic changes to subsequent generations. In Tanzania, the telecommunication sector has witnessed fast growth in the number of mobile telephone users now served by seven cellular operators. Until February 2012, there were about 26 million mobile phone subscribers served by more than 4,000 base stations spread all over the country. A considerable increase in the number of FM radio (82 stations) and TV (26) stations has also been observed. These are served by about 55 transmitting towers. Increase in other sources such as Radar was also noticed. Despite the many advantages brought by these systems, there is increased public concern over possible adverse health effects due to electromagnetic fields (EMF) radiated by these equipments.[6] Health endpoints reported to be associated with ELF and/or RF include childhood leukemia, brain tumors, genotoxic effects, neurological effects and neurodegenerative diseases, immune system deregulation, allergic and inflammatory responses, breast cancer, miscarriage and some cardiovascular effects. Regarding ELF a new lower public safety limit for habitable space adjacent to all new or upgraded power lines and for all other new constructions should be applied. A new lower limit should also be used for existing habitable space for children and/or women who are pregnant. A precautionary limit should be adopted for outdoor, cumulative RF exposure and for cumula-

tive indoor RF fields with considerably lower limits than existing guidelines. The current guidelines for the US and European microwave exposure from mobile phones, for the brain are 1.6 W/Kg and 2 W/Kg, respectively. Since use of mobile phones is associated with an increased risk for brain tumor after 10 years, a new biologically based guideline is warranted.[7]



Figure 1: Different pictures showing the electromagnetic radiations from towers[8]

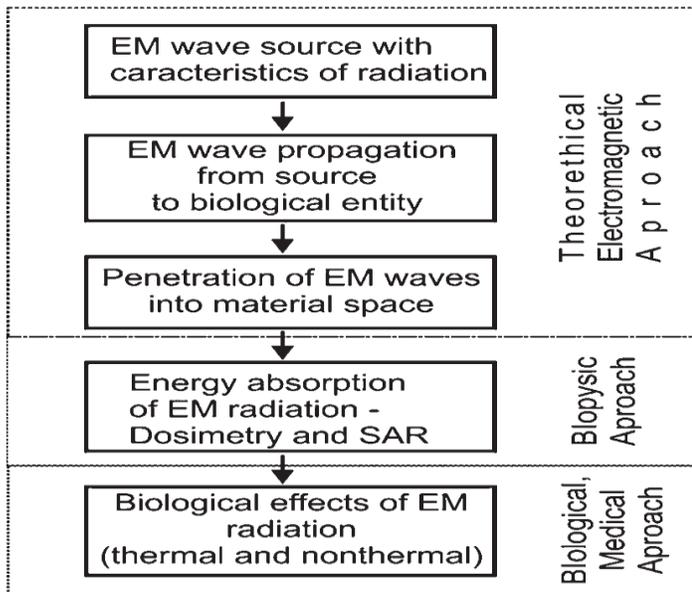


Figure 2: The procedure of examining biological effects of EM radiation emitted from the source of known characteristics according to [9]

Radio frequency electromagnetic radiation (RF-EMF) as produced by mobile phone towers, like all other forms of electromagnetic radiation cause enough of disruption to our body's cells and physiological functions to warrant real caution in the use and protection against its negative health and fertility outcomes in both men and women. There are 2 major ways in which mobile phone towers radiation may impact infertility:

1. It disrupts the hypothalamic, pituitary, thyroid, ovarian/testicular axis, which ensures optimum reproductive function – thus affecting male and female reproductive function, with sperm being most heavily affected but women also need to be very cautious because a hypothalamic/ovarian axis disruption can cause ovulatory and fertility challenges of their own kind;
2. The electromagnetic waves emitted by these devices has a direct, physical, oxidative impact on the cells in close proximity to the radiating device. [10]

The power received from transmitting power can be found by considering the power density radiated from it through the following formula;

$$S_{av} = \frac{P_t * G_t}{4 * \pi * d^2} \quad (1)$$

Where:

S_{av} = Radiated power density from cell phone tower

P_t = Power transmitted from cell phone tower

G_t = Gain of the transmitter

d = distance from the transmitting antenna to the receiver

So the average power received by human body is computed

by:

$$P_r = S_{av} * A_{eff} \quad (2)$$

Where

A_{eff} = Area of the human body (In this case, it is assumed to be cylindrical)

So, principally knowing the gain of the transmitting antenna, power transmitted from cell phone towers and the distance from the location of the cell tower to where the human being is, it could be simple for anybody to know the extent of exposure he/she is having to electromagnetic radiation. And when this received power is known, then it could be also simple to determine the SAR. The effects of electromagnetic radiation can easily be analyzed by considering the threshold values of the specific absorption rates (SAR) in which the factors like Electric field intensity (E) though relative dielectric constant (ϵ), electric conductivity (σ) and the mass density (ρ) are considered. The SAR in W/Kg can be found by:

$$SAR_{(i,j,k)} = \frac{\sigma_{(i,j,k)} * (E_{(i,j,k)})^2}{\rho_{(i,j,k)}} \quad (3)$$

E is the electric field magnitude in V/m, σ is the material conductivity in S/m and ρ is the mass density in kg/cubic meters. Also the SAR can be determined by the following relationship

$$SAR = C_p \frac{dT}{dt} \quad (4)$$

Where c is specific heat, dT is rise in temperature, and dt is a short time period, So the rise in temperature in a specified duration may cause to the raise of SAR. The SAR values always decreases when the exposed skin get or move away from the radiating cell tower antenna. So the tissues around the nearby cellphone towers are more exposed compared to the tissues which are far away from the radiating cell tower antenna.

A. REPRODUCTIVE SYSTEMS AND MALE SPERM FERTILITY

In simple terms, reproduction is the process by which organisms create descendants. This miracle is a characteristic that all living things have in common and sets them apart from nonliving things. But even though the reproductive system is essential to keeping a species alive, it is not essential to keeping an individual alive. In human reproduction, two kinds of sex cells or gametes are involved. Sperm, the male gamete, and a secondary oocyte (along with first polar body and corona radiata), the female gamete must meet in the female reproductive system to create a new individual. For reproduction to occur, both the female and male reproductive systems are essential. It is a common misnomer to refer to a woman's gametic cell as an egg or ovum, but this is impossible. A secondary oocyte must be fertilized by the male gamete before it becomes an "ovum" or "egg". While both the female and male reproductive systems are involved with producing, nourishing and transporting either the oocyte or sperm, they are different in shape and structure. The male has reproductive organs, or

genitals, that are both inside and outside the pelvis, while the female has reproductive organs entirely within the pelvis. The male reproductive system consists of the testes and a series of ducts and glands. Sperm are produced in the testes and are transported through the reproductive ducts. These ducts include the epididymis, ductus deferens, ejaculatory duct and urethra. The reproductive glands produce secretions that become part of semen, the fluid that is ejaculated from the urethra. These glands include the seminal vesicles, prostate gland, and bulbourethral glands. Because the testis is a superficial organ, it may absorb more EMW energy than other organs. Human testes need physiological temperature 2°C lower than body temperature for optimal spermatogenesis and an elevation of testicular temperature may be reversible detrimental factor to sperm production[11]

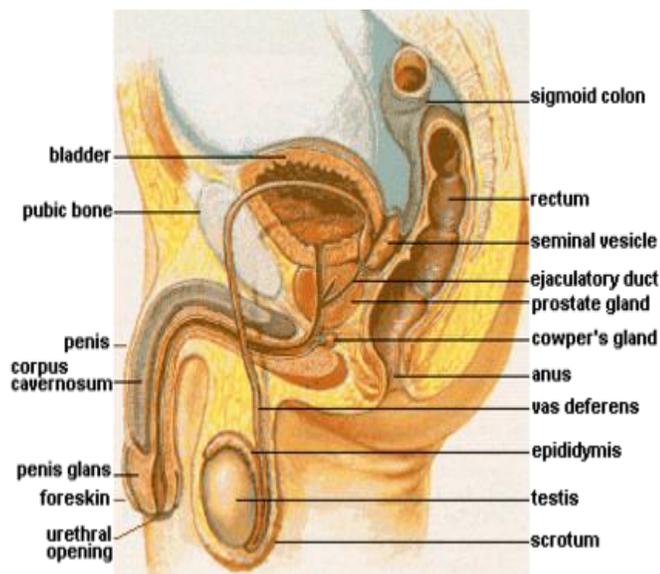


Figure 3: The human male reproductive system

The sperm is the main reproductive cell in males. The sperms differ in that each carry a set of chromosomes dividing each into either a male, or female sperm. The females differ in that they carry a X gene, while the male sperm carry a Y gene. The female sperm also differ phenotypically in that they have a larger head in comparison to the male sperms. This contributes to the male sperm being lighter, and therefore faster and stronger swimmers than their female counterparts (although statistically there is still a 50% chance of an either XY or XX embryo forming. Spermatozoan stream lines are straight and parallel. The tail flagellates, which we now know propels the sperm cell (at about 1-3 mm/minute in humans) by rotating like a propeller, in a circular motion, not side to side like a whip. The cell is characterized by a minimum of cytoplasm. During fertilization, the sperm's mitochondria gets destroyed by the egg cell, and this means only the mother is able to provide the baby's mitochondria and mitochondrial DNA, which has an important application in tracing maternal ancestry. However it has been recently discovered that mitochondrial DNA can be recombinant. Spermatozoa are produced in the seminiferous tubules of the testes in a process called spermatogenesis. Round cells called spermatogonia divide and differentiate eventually to become spermatozoa. During copulation the vagina is inseminated, the spermatozoa move through *chemotaxis* to the ovum inside a Fallopian tube or the

uterus. Fertilization is the process by which a sperm combines with an oocyte, or egg cell, to produce a fertilized zygote. The sperm released during ejaculation must first swim through the vagina and uterus and into the fallopian tubes where they may find an oocyte. After encountering the oocyte, sperm next have to penetrate the outer corona radiata and zona pellucida layers of the oocyte. Sperm contain enzymes in the acrosome region of the head that allow them to penetrate these layers. After penetrating the interior of the oocyte, the nuclei of these haploid cells fuse to form a diploid cell known as a zygote. The zygote cell begins cell division to form an embryo. Male infertility is the inability to cause a pregnancy and often is due to low sperm count. The most common causes of male infertility are related to sperm usually problems with sperm count and the quality of that sperm. Sperm-related problems includes low sperm count, sperm that don't move quickly enough they die before they reach the egg, sperm that are not formed correctly, seminal fluid that is too thick sperm can't move around in it very easily and no sperm. Heat can have a detrimental effect on normal sperm production. Too much time spent soaking in a hot tub can raise the temperature of the testicles and interrupt sperm production.[12] Sperm-related problems may result from too much or too little of some of the hormones that guide sperm making. Another cause of male infertility is a problem with ejaculation. In some cases, tubes inside the male reproductive organs are blocked. If so, you may have a hard time ejaculating, or nothing comes out when you have an orgasm. Sometimes, the ejaculation goes backward from the prostate into the bladder instead of out of the body.

III. METHODOLOGIES

The biological effects of electromagnetic radiation are studied through investigations and research such as numerical bioelectromagnetic modelling, experimental (*in vivo* and *in vitro*) investigations and epidemiological studies. A multidisciplinary approach is crucial to obtain relevant information on the biological effects. The technical sources of radiation and their key features are best known to the engineers engaged in their design, while the process of propagation and absorption is analyzed by applying the physical laws of propagation, technical methods of analysis and simulation[9]. In order to determine the biological effects of electromagnetic waves electromagnetic radiation it is extremely significant to define the amount of absorbed energy of the incidental wave and its distribution in the volume of the object. Also various frequencies for GSM (from 900MHz and 1800MHz) and CDMA (800MHz) have been used in simulating the results to find the Electric field and Magnetic field variation with the mentioned frequencies and fixed transmit power using FEKO simulation software or tool. It is rather difficult to recreate the real internal structure of tissues and organs. That is why we apply simplified organ and tissue modelling. This makes it possible to model tissues from homogeneous layers that constitute the skin, subcutaneous tissue, bones, skulls, etc., whereas organs are modelled as ellipsoidal structures resembling for instance the brain, eyes, kidneys, or stomach. Such models are suitable for use in numerical simulation programs alongside source models (mobile phones, antennas, etc.). [9] The obtained results of the field components, absorbed energy and SAR values in such models, although numerically correct, are not very useful for medical professionals since these results cannot be easily associated with biological effects.[13] This is due to the fact that they do not entirely reflect the true structure, thus making

it difficult to localize anatomical structures. For example, in a descriptive model of the head, it is not possible to locate the pineal gland and calculate the amount of energy absorbed in it, although some studies have indicated that the pineal gland is particularly sensitive to the effects of electromagnetic radiation I do assume that it is possible to link the results of modeling absorbed energy in tissues with the real structure of the tissue, and thus locate the parts of tissue where the biological effects of radiation can be seen. For example in this case I assume that the tissue present in testes are the investigative parts which can give us the required simulated results.

IV. RESULTS AND DISCUSSIONS

After going through the methodologies above, analysis has been done on the experimental values obtained through the use of FEKO software at GSM frequencies of 900MHz and 1800MHz and CDMA frequency of 800MHz at various distances from where the cell phones towers is, to the position of the testes.

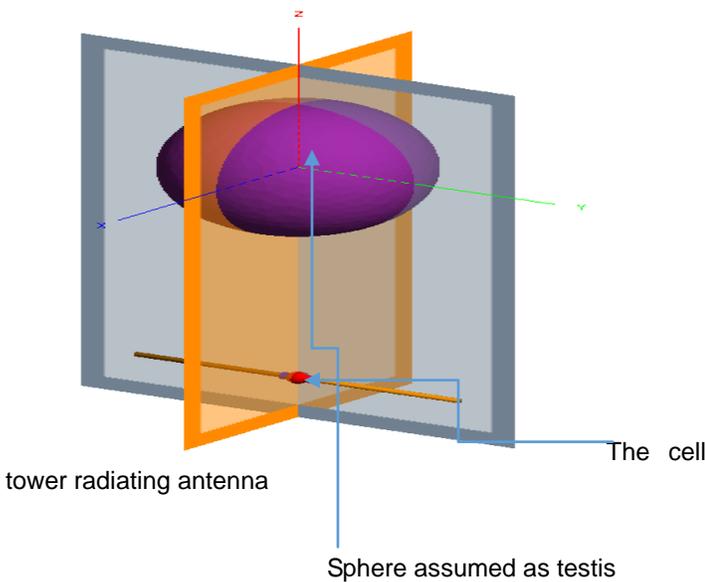


Figure 4: Showing the setup of the experimental analysis of the radiation effects on testis

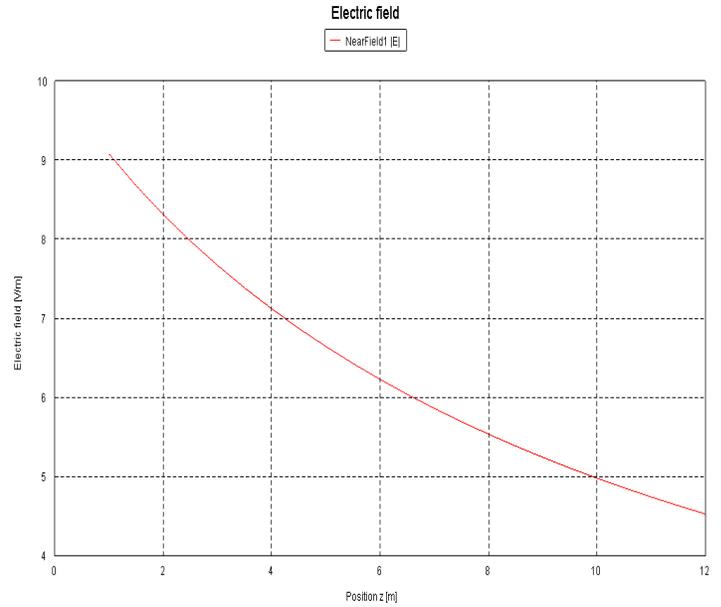


Figure 7: Showing the simulated results of Electric field against position of the tower.

From Figure 7 above it is observed that whenever the distance between the mobile phone tower and the testis position decreases then the electric field absorbed by the testis increases which eventually increases the SAR of the testis by considering the fact that, the SAR of the body is directly proportional to the square of electric field ($SAR \propto |E|^2$ where E= electric field intensity in V/m.)

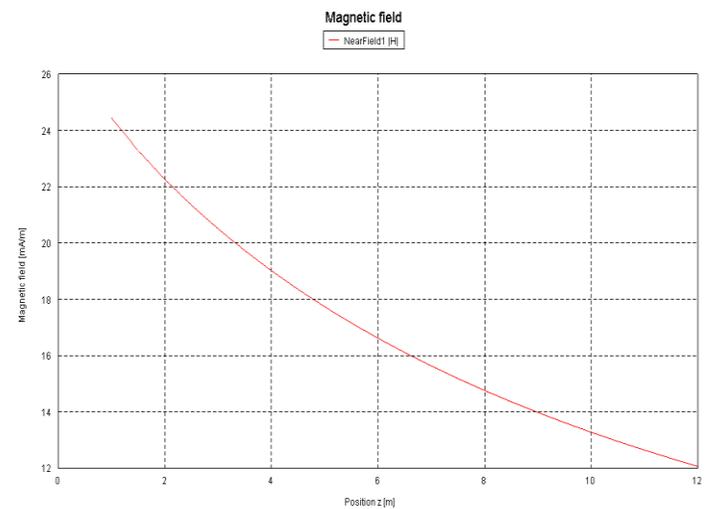


Figure 5: The graph showing the relationship between magnetic field and the position between the male testis and the mobile phone towers.

It is observed that there is an inversely proportional relationship between the magnetic field and the position (or distances) as when one variable increases, the other decreases and since magnetic field intensity is directly proportional to the electric field then that means the SAR also directly relate to the magnetic field so the increase in magnetic field intensity causes to the increase in SAR of the testis and which finally causes the male sperm infertility if exposed for a while.

V. CONCLUSION

Since there is energy absorbed by testis tissues during radiation (received power from the mobile phone towers also found as the product of radiation power density times effective area of the testis), this electromagnetic energy is easily converted to thermal energy and thus can disturb sperm production which will eventually lead to low sperm count and hence cause infertility problem, also this thermal energy can lead to the reduced sperm motility which also contributes to infertility as the sperm speed is being reduced to the extent that it can struggle to reach the female egg for ovulation. The SAR values always decrease when the exposed skin/tissues get or move away from the radiating mobile towers antenna. So the tissues of the people (male) around the nearby towers are more exposed compared to the tissues of the people (male) which are far away from the radiating mobile towers antenna. So living close to the mobile phone towers can lead to male sperm infertility because.

RECOMMENDATIONS

From this study, I recommend that the regulatory authorities should restrict the mobile phone operators to erect/build their towers nearby surroundings where people are living because if you are living on the main beam of cell phone towers then you are exposed to comparatively high radiation levels and they should provide the safe distance to build those towers. Also avoid wearing tight underwear as they increase scrotal temperature which causes the decrease in sperm production and hence cause infertility.

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