

Male infertility and its link to microplastics: A sterile future

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Infertility is defined as the inability of a couple to conceive after 365 days of unprotected, regular intercourse. There are various forms of infertility, both primary and secondary, as well as both male and female infertility. In the last 40 years, male sperm counts have halved, and the sperm quality of males has dropped significantly. The global statistics surrounding infertility and sterility are frightening. The topic of infertility is one of contention and is often swathed in a veil of taboo [1]. Very strong negative emotions may cloud a couple who struggles to conceive and may struggle to cope with such devastating life-altering news healthily. Thus, the final result may be the termination of a relationship. Another great challenge is the lack of adequate counselling and medical attention; many couples are often never given a full, explicit diagnosis.

Global figures:

It is now estimated by the WHO (World Health Organization) that 17.5% of the adult population, which accounts for 1 in 6 people, will suffer from infertility within their lifetime [2]. Traditionally, the “fault of infertility” has been aimed at the female counterpart in a relationship; however, as science and medical technology have improved, it is now clearly evident the large role that males have to play in couples who are struggling to conceive. It is estimated that males are solely responsible for 20% of infertility in couples. Global statistics indicate that there are 180 million couples who suffer from infertility worldwide [3].

Causes of male infertility:

There are a host of causes for male infertility, which can range from genetic to traumatic. Generally, the causes of male infertility can be divided into pre-testicular, testicular, and post-testicular causes [4].

Pre-testicular causes:

Endocrinopathies include disorders of the secretion or production of gonadotrophin-releasing hormone, luteinizing hormone, follicle-stimulating hormone, and androgen function.

Testicular causes include genetic abnormalities, the presence of a varicocele, and gonadotoxins (radiation, drugs: calcium channel blockers, alpha-blockers, spironolactone, cimetidine, allopurinol, and microplastics). Trauma to the testicle and testicular abnormalities may also result in infertility [5].

Post-testicular causes: Immunological infertility, mechanical obstruction, ejaculatory disorders, and erectile disorders [5].

Microplastics and male infertility:

A recently discovered and widely implicated gonadotoxin, which may be one of the major drivers behind the current infertility figures, is microplastics. Microplastics have been a part of the human race's environment since the 1950s [6]. Microplastics and nanoparticle's (MNP's) pervasive presence and potential impacts on the reproductive system are a global concern. "Microplastic" is < 5 mm in length and a nanoparticle range between 1 to 1000 nanometres in size. We are exposed to these MNP's in some way, shape, or form. Many studies have been conducted to estimate the intake of microplastics in the average diet. A study performed by Cox et al. generated alarming figures for microplastic intake and quantified that the annual intake of microplastics amounted to almost 15% of the American people's caloric intake. This intake spans from ingestion to inhalation. A surprising notion raised by the study was that bottled water is marketed as a "healthier and safer" alternative to tap water. It was, however, evident that individuals who solely consumed bottled water ingested an additional 90,000 microplastics per year compared to those who drank tap water [7].

A startling discovery was made in research conducted by Xiaozhong et al. at the University of New Mexico on testicular samples of canines and humans. The study proved that not only did microplastics permeate into the urogenital and reproductive systems, but they also accumulated in the native tissue. The most common pollutant present in both human and canine testicular tissues was PE (polyethylene), used in the production of commonly used items such as plastic bottles and bags. The study quantified the presence of the MNP's and found that the average concentration of MNP's in the canine testicular tissue was 122.63 micrograms per gram of tissue. In the human samples, a further morbid result was noted; it was shown that humans had three times the concentration of microplastics in their testicular tissues as compared to their canine counterparts at 329.44 micrograms per gram. It was further noted that the sperm count could not be performed on the human tissues due to the preservation process; however, the sperm counts in the canine samples were shown to be reduced. The comparison between canine and human testicular tissue is apt as the process of spermatogenesis is similar, and the effects of MNP's on the canine testicular tissue will mirror what occurs in that human testicular tissue [8].

Mechanism of microplastics and male infertility:

The relationship between male infertility and reduced sperm counts and quality and the presence of these adulterants/pollutants in testicular tissues is irrefutable.

The mechanism behind the gonadotoxic mechanism is still in question. It is believed that these pollutants have both a chemical and physical mechanism behind the disruption of spermatogenesis. The MNP's act as EDCs (endocrine-disrupting chemicals) that simulate the structure and activity of steroid hormones, disrupting and upsetting the homeostatic functions and processes of spermatogenesis [9].

Expert opinion:

The omnipresence of microplastics in our environment, making our exposure inevitable, is both a sobering and alarming fact. It is evident that these pollutants affect us in many ways and permeate into the deepest cores of our anatomy. Not only do they permeate into our bodies, but these MNP's further act as toxins and cause homeostatic dysregulation. In the case of males, they have been shown to reduce both sperm quality and quantity. It is pertinent that larger studies into the link between microplastics and male infertility are undertaken, which can further pressure lawmakers to impart more stringent policies and legal implications surrounding the use of plastics, thus ultimately reducing the use of plastic and the presence of MNP's in our environment. It is recommended that the general population reduce the use of plastics in every aspect of their day-to-day lives and switch to using glass containers, bottles, and food storage containers as a plastic alternative.

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Abbreviations

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