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Trace Element's Role in Male Infertility; Review Article

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ABSTRACT

Background: Trace elements are the basic components of biological enzyme system or the structural components of very low concentration bioactive components. There are a number of trace elements in foods, such as iron, iodine, fluorine, copper and zinc, as well as chromium and cobalt. Other trace elements include tin and vanadium. Nickel and silicon are two examples of metals. Some of the trace elements are toxic to reproductive health at high doses. Trace amounts of these substances are rarely used for various physiological functions of the body. Many metal ions (copper, arsenic, cadmium, chromium, nickel, lithium vanadium, lead, and mercury) have many adverse effects on reproduction and development, fertility of men and women, abortion, and deformity. Exposure timing and duration, metal ions' distribution and accumulation in various organs, and interference with specific developmental processes; all have an impact on the consequences of metal ions.

Objective: To assess the trace element's role in male infertility especially the role of zinc.

Conclusion: Trace elements are very important for the sperm production and quality and could affect the male fertility by one way or another.

Keywords: Male Infertility, Trace Elements.

INTRODUCTION

Environmental, dietary, lifestyle, and work-related factors all have a significant impact on a wide range of health issues, such as cancer, cardiovascular diseases, reproductive and developmental defects. In the past few decades, many aspects of our diet, lifestyle, and environment have changed gradually. In lifestyle, consumption of tobacco, drinking alcohol or using illegal drugs or any combination of these has a significant negative influence on one's overall health. Numerous medical conditions including high blood pressure, diabetes, lipids that are out of control, and obesity, cardiovascular disease, and even some types of cancer are related to nutrition and lifestyle factors to a certain extent. These factors may also be the reasons for increasing reproductive disorders in men and women. Reproduction is an important biological activity of all organisms. Cancer of the testicles, congenital defects such cryptorchidism and urethral malformation, and a scrotum all affect the quality of the male reproductive fluid (semen) [(1)].

Abnormal concentrations of certain elements are linked to certain clinical conditions. For example, a lack of balance in at least 19 components might cause issues during human reproduction, embryogenesis, and pregnancy. Mercury, lithium, boron, aluminium, lead, chromium, manganese, and iron, as well as, selenium, nickel, copper, zinc, arsenic, cadmium, cobalt, tellurium, molybdenum, indium, and iodine are among these elements [(2)].

The components of the human body come in a variety of shapes and sizes. Essential elements must not only exist, but must also be present in the correct quantities and oxidation states, as well as paired with the appropriate chemical partners, in order to preserve optimal health [(3)]. For this reason, morphological analysis is critical in the quest to find the cause of and treat physical ailments. This will reveal the presence of specific chemicals and explain the internal balance (constant excretion and rearrangement) and trace element intake and metabolism mechanism [(4)].

According to its concentration in nature, elements can be divided into primary, secondary, trace, or ultra-trace elements. In human body, primary /there are a number of secondary elements as well as a number of ultra-trace/trace elements. The secondary elements include: H, C, N, O, Na, Mg, P, S, Cl, K, and Ca, while the ultra-trace elements include: F, Si, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Mo, Sn, and I [(3)].

Role of trace elements in human health:

As well as reducing and oxidizing reactions, membrane permeability, the function of subcellular organs (such mitochondria), and the production and stability of proteins and nucleic acids, trace elements are engaged in other biological functions [(5)].

Seminal plasma:

Testes and the male reproductive organs combine to generate semen, which is a chemical solution. Sperm suspended in seminal plasma make up this substance. It is

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the job of seminal plasma to supply sperm with an optimally osmotically pressured, nutrient-rich environment. In addition to activating sperm, seminal plasma can also make sperm more active because of the sperm's tiny cytoplasm**.** The amount of sperm per ejaculation is 2-4 ml, with an average of 200 million sperm per ml [(6)]**.**

The content of sperm varies greatly, so sperm density and motility are used to determine sperm motility [(7)]**.** Various therapeutic strategies, like follicle-stimulating hormone, have been utilized to increase sperm count and quality to stimulate spermatogenesis and interstitial cell-stimulating hormone (ICSH) to stimulate testosterone [(8)]**.**

Table (1): "Normal" levels of trace elements in seminal plasma [(9)]

Element	Normal Range in seminal Plasma (microgram/ ml)
Se	0.021-0.191
Fe	0.05-0.63
Cu	0.03-0.3
Zn	18-301
Mn	0.08-030
Mo	-
I	-
Cd	0.00015-425
Pb	0-0.049

Male infertility is frequently studied using seminal plasma, which is collected from men's testicles. Infertile men, for example, had much greater levels of lead in their seminal fluid, according to research (3.6 ± 3.2 ug L^{-1}) compared to fertile men (1.7 ± 1.0 ug L^{-1}) ($P = 0.001$) [(10)]**.** Low sperm counts have also been connected to aluminum intake in the blood ($P = 0.05$) [(11)] and a lack of zinc and selenium in the blood has been linked to poor quality sperm [(12)]. Zinc and selenium have been demonstrated in research to improve sperm quality and quantity while protecting testicles from cadmium-induced damage [(13)]**.**

Zinc:

A vital mineral for healthy growth, neurological system function, and immune system response, is zinc [(14)]**.** Zinc is an essential trace element for the human body and participates in electron transfer in many enzyme reactions [(15)]**.**

Zinc is found in small amounts in the bodies of adults, ranging from 1-3 grammes, with an average daily intake of less than 0.1 percent. Zinc is a critical human micronutrient. Low zinc intake will lead to poor health, reproductive problems, and decline of disease resistance. Excessive zinc intake will also be harmful to human health [(16)]**.**

A healthy diet rich in zinc promotes physical and mental development as well as reproduction. Zinc in sperm plays an important role in sperm physiology. Zinc in sperm can stabilize sperm cell membrane and nuclear chromatin and has an antibacterial effect. To put it another way, a lot of zinc can be found in various parts of the male reproductive system. Spermatogenesis is dependent on testicular zinc, which is an essential nutrient [(17)]**.**

Kvist *et al.* [(18)] discovered a link between zinc in sperm nuclei and detergent-induced anti-depolymerization of chromatin. The stability of sperm chromatin in male infertility was poor and the content of sperm zinc was low, which may damage the antioxidant capacity of sperm. The male genome is more vulnerable because to the structural stability of chromatin. The sperm motility and penetration of ZP-free hamster oocytes may be affected by a high zinc content in the culture media. Recently, sperm zinc concentration in low fertility men is related to sperm number and abstinence time, while sperm zinc concentration in normal sperm density men is related to sperm number and abstinence time. A high concentration of zinc in sperm may have a negative effect on ZP-induced acrosome reaction [(19)]**.**

Early studies showed that semen and serum zinc levels were not associated with asymptomatic male reproductive tract infection (taking sperm leukocytes as indicators); In addition, they observed that zinc did not affect the ability of sperm to enter cervical mucus or subsequent fertility in vitro or in vivo [(20)]**.**

There are conflicting findings regarding the zinc concentration of semen and several semen qualities measures. The level of seminal zinc has been linked to sperm count, sperm morphology, sperm density, motility, and viability, as well as abstinence length, volume, and pH [(21)]**.** However, zinc was shown to be linked to an increase in sperm quantity, motility, and plasma testosterone concentration in **Fuse *et al.*** study [(22)]**.** Zinc, according to **Ali *et al.*** [(23)] affects sperm parameters greatly, which helps with fertility.

Estimating seminal plasma zinc may be useful in the study and treatment of infertile men, according to the research. **Carreras and Mendoza** [(24)] on the other hand, found a link between zinc intake and decreased sperm motility. Men with high total zinc consumption had 50% lower x-dimer frequency than men with medium zinc intake, whereas men with low zinc intake had 39% lower x-dimer frequency. There was no link found between sperm aneuploidy with antioxidant or zinc intake [(25)]**.**

According to **Wong *et al.*** [(26)] there was a weak link between plasma sperm count and zinc content**.** The concentrations of zinc and magnesium in seminal plasma were weakly correlated with the number of sperm and the concentration of active plasma copper**. Mankad *et al.*** [(27)] found that azoospermia patients had the lowest levels of α-glucosidase activity when compared to oligospermia patients and the normal control group, and zinc levels were positively correlated with sperm count, seminal

plasma zinc, and α-glucosidase activity in the seminal circulation.

Changing zinc levels in seminal plasma have been shown to alter sperm quantity, motility, pH, and viscosity, according to **Dissanayake *et al.*** [28]. Rather than the overall amount of zinc in seminal plasma, another study found that high molecular-weight zinc's binding property was a good indication of sperm function [29].

In comparison to fertile groups, subfertile populations exhibited lower seminal Zn levels [30], whereas some have reported seeing no difference [31]. Because zinc inhibits DNase, it keeps sperm active while also being an antioxidant [31]. There's some evidence that zinc after-ejaculation can be a "powerful scavenger" of the superoxide anions generated by sperm and/or faulty leukocytes [32]. To deal with too many superoxide anions, seminal plasma's high zinc concentration seems sufficient as an antioxidant. Zinc has anti-oxidant qualities and is crucial in the removal of reactive oxygen species, according to the recent research [33,34].

Scientists have discovered a link between zinc deficiency and poor sperm quality, as well as idiopathic male reproductive problems. High zinc levels, on the other hand, may prevent sperm motility and mannose receptor function in the sperm head. Seminal plasma zinc, according to **Lewis-Jones *et al.*** [35] is an unreliable indicator of spermatogenic activity. However, a large number of studies have shown that it plays a positive role in male reproduction.

In spermatogenesis and metallothionein induction in hepatocytes, zinc plays a key role, and zinc pretreatment can protect animals and cell cultures against the acute toxic effects of cadmium. Smoking heavily has been linked to low sperm counts, poor motility, abnormal morphology, and a high level of cadmium in sperm[19].

CONCLUSION

Trace elements are very important for the sperm production and quality and could affect the male fertility by one way or another.

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