

## Male Infertility: The Underestimated Impact of Diet and Nutritional Factor

\*Dr. Ravi Bala Goyal

### Abstract

Men are the only cause of up to 50% of infertility cases. According to research, the quality of human semen has significantly decreased by 50% to 60% during the last four decades. In addition to having an influence on sperm shape, unhealthy lifestyle choices that lead to high-fat diets and obesity also have an adverse effect on the long-term health and development of kids. Obese individuals often have changed levels of the other hormones, greater estrogen levels, lower levels of testosterone, lower levels of luteinizing hormone (LH), and lower levels of follicle-stimulating hormone (FSH), as well as the hypothalamic-pituitary-gonadal axis. A balanced diet has been shown to enhance sperm quality and reduce the likelihood of problems in sperm count, concentration, motility, and DNA integrity. Along with essential minerals like zinc and selenium, it is also important to emphasize the role that omega-3 fatty acids and antioxidant vitamins play in reducing oxidative stress and inflammation. The addition of carnitine and coenzyme Q10 supplements might prove to be a successful tactic. A diversified and well-balanced diet consisting mostly of low-fat dairy products, poultry, fruits, vegetables, fish, and other seafood, as well as nuts and seeds, is thus advocated.

**Keywords:** Sperm Count, male infertility, nutrition, diet, antioxidants

### Introduction

A developing segment of society is affected by infertility, which is the inability to get conceived while having frequent, at least annual sexual activity without the use of contraception. Around 70 million couples of reproductive age, or up to 15% of all couples globally, are thought to have difficulty becoming conceived, with approximately 50% of these instances being connected to male infertility. According to reports, 34% of infertility cases exclusively include women, 20% involve both men and women, 29% involve issues that just affect the male, and 15% of infertility cases are unsolved.

Oligospermia, or a low sperm concentration in the semen, asthenozoospermia, or a total absence of motility or a reduced motility of spermatozoa, and teratozoospermia, or a lack of spermatozoa with a normal structure, are some of the distinctive characteristics of male infertility. Infertility in males is caused by these conditions more than 90% of the time, according to Leaver. More than 40,000 men from developed countries participated in 185 studies, and a thorough meta-analysis indicated that between 1973 and 2011, the number of spermatozoa increased.—the primary factor influencing the

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quality of semen—decreased by 55% to 60%. The average and median values of the seven factors influencing sperm quality in a Polish study of 159 young, healthy males from the Lower Silesia region who were unaware of their reproductive status were discovered to be within the standards established by the World Health Organization (WHO) in 2010. Sperm viability, on the other hand, was bordering on the lower edge of the normal range, and the average percentage of sperm with an abnormal structure, at 84%, was startlingly high. Additionally, in more than 10% of the cases looked at, one, two, or three values were beyond the allowed range.

Smoking, cannabis use, anabolic steroid use, excessive alcohol use, prolonged exposure to high temperatures, age, emotional stress, environmental pollution, tight clothing, sedentary lifestyle, radiofrequency electromagnetic radiation, exposure to pesticides and toxins, as well as cadmium, cytotoxic drugs, and lead, all have a significant negative impact on male fertility. It's crucial to realize that certain factors, like age, contamination from the environment, or radiation, are beyond of a person's control. It's crucial to comprehend that certain factors, like age, or radiation, environmental contamination, are beyond of one's control. Studies suggest that resveratrol, together with other antioxidants, may provide a potential medicinal substitute.

Recent research has also shown a substantial link between diet and semen quality, highlighting the need of living a healthy lifestyle in general to promote reproductive functions.

Elevated levels of oxidative stress, a significant contributor to conditions such as obesity, disrupted intestinal balance, type 2 diabetes, and insulin resistance, may have a direct association with unhealthy diets characterized by excessive calorie intake, high levels of saturated and trans fats, foods with high glycemic indexes, and inadequate nutritional content. These metabolic abnormalities have been linked to a decline in fertility, primarily due to the increased production of oxidative stress. It is understood that this oxidative stress has a significant role in low sperm quality, increased infertility risk, as well as hormonal and immunological diseases. In addition, the quantity of white adipose tissue is inversely correlated with the generation of pro-inflammatory cytokines, reactive oxygen species, and the activity of the aromatase enzyme, which converts testosterone to estrogen. The risk of secondary hypogonadism is higher in men who are obese, have type 2 diabetes, insulin resistance, and low levels of SHBG. Hyperglycemia also has a detrimental effect on sperm motility and the process of fertilization.

In order to cure male infertility induced by aberrant sperm parameters, dietary intervention seems to be a crucial component.

### **The Impact of a Dietary Pattern on Male Infertility Risk**

In recent decades, the primary nutritional paradigm of developing and established countries has shifted towards the so-called western diet. This dietary pattern is characterized by a high intake of animal proteins, saturated and trans fatty acids, and basic carbohydrates, while lacking in dietary fiber and essential unsaturated fatty acids (EFA). In addition, it is a high-calorie diet with poor nutritional density that encourages inflammation.

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The quality of semen has noticeably decreased as the western diet becomes more pervasive. Poorer semen parameters and decreased fertility have been associated with diets high in processed foods, red meat (as some sources suggest), fatty dairy products, coffee, alcohol, sugary drinks, sweets, and potatoes and low in whole-grain foods, vegetables, fruits, poultry, fish, and other seafood, nuts, and lean dairy. Male infertiles have been shown to have hazardous eating habits include missing meals, receiving inadequate antioxidants, and ingesting a diet abundant in calories. A diet abundant in fat and the obesity that results from an unhealthy lifestyle may also have long-term effects on the health and development of future generations, in addition to having an influence on sperm morphology.

It is evident that dietary choices play a crucial role in male infertility, emphasizing the significance of adopting healthier dietary patterns.

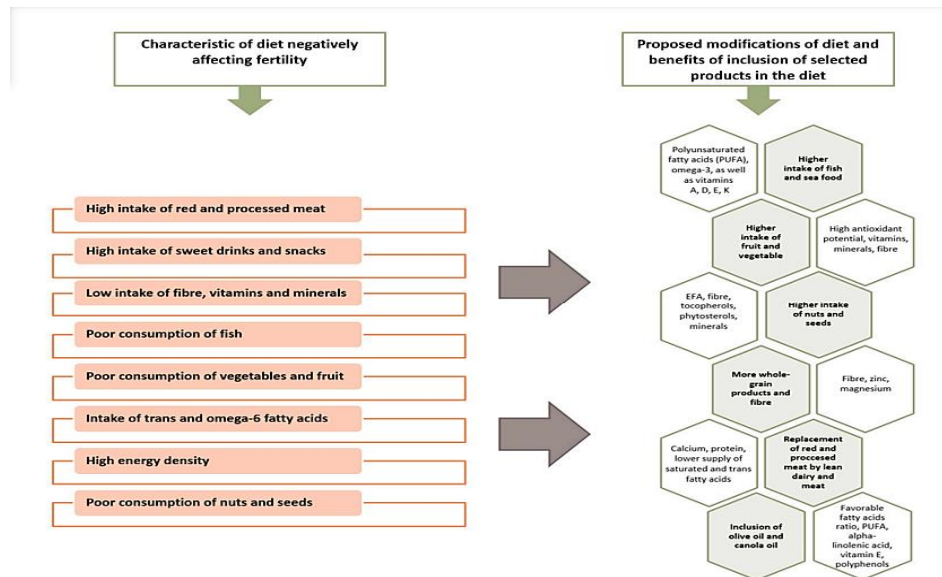


Figure 1. A diagram illustrating the traits of a diet that can have a negative impact on fertility and potential adjustments.

### 2.1. Meat

The ingestion of meat, particularly processed meat, has a negative influence on fertility, according to published research papers. The high levels of saturated and trans fats in meat, the presence of preservatives and hormone residues, and other variables might all have a deleterious influence. In comparison to unadulterated beef, processed red meat has been discovered to include greater residues of active compounds that may be able to alter the endocrine system. Furthermore, the trans fatty acids present in meat have been linked to a potential detrimental influence on sperm quality.

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According to a research by Afeiche et al., red processed meat consumption is negatively correlated with both the proportion of progressive sperm motility and the total quantity of spermatozoa in the ejaculate.

### **2.2 Saturated and Trans fatty acids**

A cross-sectional research involving a group of healthy men produced intriguing findings on the impact of dietary variables on testicular endocrine function. The results showed a significant decline in testicular function linked to trans and omega-6 fatty acid consumption, along with a decrease in omega-3 intake. Lower levels of free and total testosterone as well as a reduction in testicular volume were the main features of this drop.

In another cross-sectional research including healthy males, the attention moved to the intake of saturated fats and its possible implications on male fertility. The results suggested that a greater diet of saturated fats was connected to reduced sperm concentration and a reduction in semen count. These findings provide light on the relevance of dietary choices and their influence on reproductive health.

Both investigations thoroughly gathered semen and blood samples from the subjects to acquire reliable measurements and statistics. Additionally, the participants were asked to complete questionnaires that addressed different elements of their lifestyle, health, and food. It is worth mentioning that in one study, the participants were uninformed of their reproductive status, which lends impartiality and dependability to the research conclusions.

These studies demonstrate the necessity of incorporating dietary variables when assessing male reproductive health. The results underscore the possible importance of certain fatty acids, such as trans fats, omega-6 fatty acids, and saturated fats, in altering testicular function and semen quality. Such research gives useful insights into the influence of nutrition on male fertility and highlights the need of adopting educated dietary choices to promote good reproductive health.

### **2.3 Caffeine**

There has been a lot of debate over the potential consequences of caffeine usage on male reproductive function, especially in relation to sperm DNA abnormalities. However, the majority of studies that have been conducted so far do not provide strong proof of a link between moderate coffee use and male fertility. There was no compelling proof that coffee consumption had any appreciable impact on sperm quality, according to a meticulous meta-analysis that examined 57 cross-sectional studies involving a total of 29,914 individuals. Intriguingly, a study of 28 observational studies including 19,967 males found no evidence that caffeine from coffee, tea, or cocoa beverages had a detrimental effect on the quality of semen. However, multiple investigations found a link between drinking caffeine-rich saccharine beverages and reduced sperm volume, count, and concentration. These findings suggest that the health of male reproduction may be influenced by various components of certain caffeinated beverages rather than just caffeine.

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## 2.4 Phyto-Estrogen

Controversies surrounding men's reproductive health are also linked to phytoestrogens. Phytoestrogens are naturally occurring compounds of plant origin that manifest estrogen-like activities. The most well-known group of phytoestrogens is isoflavones, specifically genistein and daidzein, which are prevalent in soybeans and soy-based products. These isoflavones have been proposed as a potential alternative to hormone replacement therapy for menopausal women and exhibit antimutagenic and antioxidant properties.

It should be emphasized that different populations exhibit diverse abilities to convert soy into equol, a non-steroidal estrogen, influenced by genetics, diet, and gut microbiota composition. Nevertheless, recent studies have not established a definitive association between moderate consumption of soybeans and an increased risk of infertility, decreased semen quality, or lowered blood testosterone levels. In fact, certain studies have even indicated potential improvements in sperm quality measures. Nonetheless, additional studies concentrating on the effects of isoflavones are required to provide a more definitive understanding of the impact of soy consumption on fertility.

## 2.5 Hypercaloric Diet: A diet characterized by excessive caloric intake

In recent decades, significant changes in lifestyle patterns have been observed, including decreased physical activity, increased consumption of high-calorie and high-fat meals with a high glycemic index, and inadequate dietary fiber intake. Consequently, obesity rates have risen dramatically worldwide, leading to an epidemic. In Europe, more than half of the population is affected by overweight and obesity, with men being more prone to these conditions compared to women. The adverse consequences of being overweight are well-documented, as they can contribute to various diseases such as osteoarthritis, diabetes, hypertension, cardiovascular problems, cancer, and sleep apnea. Furthermore, obesity negatively impacts women's reproductive health.

In order to treat male infertility, addressing obesity via weight reduction is seen as a crucial and first step.

### **The Relationship Between Unhealthy Dietary Patterns, Obesity, and Infertility: Underlying Mechanisms**

Obesity, poor eating habits, and infertility are all associated with oxidative stress, which is now understood to be a major factor in male infertility. This stress is brought on by a decline in antioxidant activity and a malfunctioning mitochondria in spermatozoa. The impact of oxidative stress on sperm quality and fertility is seen in Figure 2.

Male infertility is thought to be caused by reactive oxygen species (ROS), which have a detrimental effect on sperm motility and their capacity to fertilize an egg, in between 30% and 80% of instances. Figure 2 shows how damage to sperm DNA, proteins, and cell membrane lipids may occur when ROS overwhelm the antioxidant defense mechanism. Therefore, higher levels of oxidative stress are linked to worse sperm motility, a lower viable sperm count, a lower concentration of sperm in semen, a

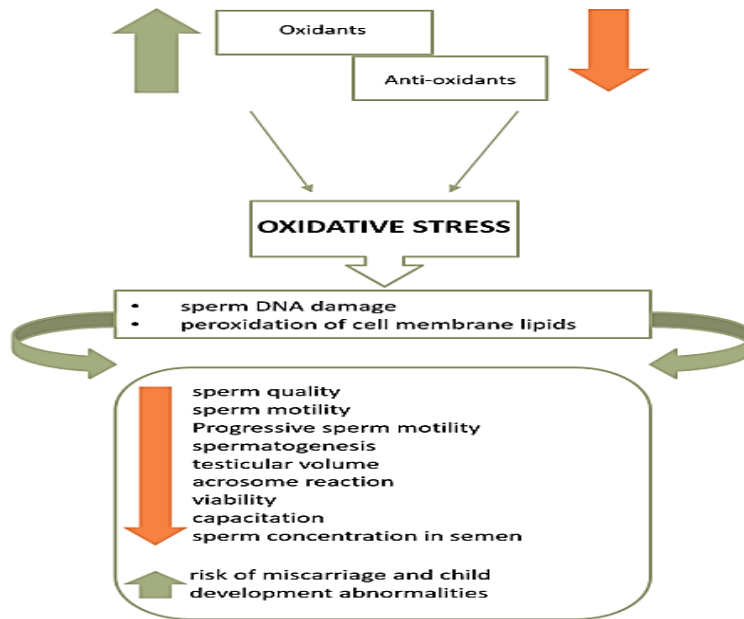
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higher chance of miscarriage, and a higher risk of developmental problems in offspring. Moreover, declining sperm morphological parameters are also associated with increased ROS generation.

Consuming foods that promote inflammation, eating few foods strong in antioxidants, eating a diet with a high glycemic index and load all contribute to increased oxidative stress. Additionally, spermatogenesis is substantially impacted by glucose metabolism, and high blood sugar (hyperglycemia) may negatively impact sperm motility and fertilization.



**Figure 2. Examining the Effects of Oxidative Stress on Sperm Quality and Reproductive Potential**

### Understanding How Imbalances in the Intestinal Microbiota Affect Male Reproductive Function

Recent research has looked at how the intestinal flora influences health. A collection of microorganisms that reside in the digestive system is known as the intestinal microbiota. It is made up of roughly 100 trillion microorganisms that operate in symbiosis and mutualism with the human body. In the adult gastrointestinal tract, Firmicutes, Bacteroidetes, Actinobacteria, Proteobacteria, Verrucomicrobia, and Fusobacteria are the most common bacterial species. Numerous elements of human health, including the immune system and susceptibility to metabolic disorders, are impacted by the composition of the intestinal microbiota. The composition of the intestinal microbiota may be

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substantially altered as a consequence of diet.

Poor diets that are rich in fat and monosaccharides may induce intestinal dysbiosis, which is a quantitative and qualitative change of the composition of the intestinal microbiota and an increase in the permeability of the intestinal barrier. Chronic inflammation results in the occurrence of several disorders in the body, including visceral sickness, type 1 diabetes mellitus, colon cancer, inflammatory bowel disease, and obesity.

The major finding of the study is that a high-fat diet may lead to an increase in Firmicutes-type bacteria *Mollicutes* and *Clostridium* as well as *Proteobacteria Bilophila* and *Enterobacteriaceae*, while concurrently resulting in a decrease in Firmicutes-type bacteria *Bifidobacterium*, *Akkermansia muciniphila*, *Bacteroidetes* and *Lactobacillus*. While *Lactobacillus* bacteria have anti-inflammatory qualities and stimulate the transit of short chain fatty acids (SCFA), *Bifidobacteria* have the capacity to alter the intestinal barrier, lower the amount of lipopolysaccharide, and treat endotoxemia.

According to certain hypotheses, a diet deficient in soluble fiber fractions may also contribute to the unfavorable alterations in the microbiota composition. Contrarily, polyphenols could support the integrity of the intestinal barrier being restored.

#### **Developing a Dietary Plan to Enhance Male Fertility**

Multiple organ secretions are combined to form male semen. In addition to fructose, seminogelin, vitamins C and E, prostaglandins, carnitine, glycerophosphato-choline, and neutral alpha-glucosidase, it also contains acid phosphatase, citric acid, inositol, copper, calcium, zinc, and magnesium. Sperm also contains potassium, sodium, carotenoids, glucose, selenium, urea, lactic acid, cholesterol, and other electrolytes. Sperm's pH ranges from 7.2 to 8.2 depending on nutrition. Seminal vesicle secretions make up around 70% of the semen's volume. A significant portion of these essential nutrients, which are required for normal spermatogenesis, spermatozoa maturation, and function, are obtained through diet.

Therefore, spermatogenesis, sperm quality, and male fertility may all be affected negatively by a diet that is deficient in certain nutrients.

Healthy eating habits have been linked to better sperm quality, as well as a lower chance of abnormalities in variables such sperm quantity, motility, DNA fragmentation and concentration, according to research studies. It is advised to adhere to a dietary norm that includes a high consumption of fresh vegetables, fruits, whole grains, and fiber-rich items in order to improve male fertility. Contrarily, as seen in Table 1, items made with refined flour should be avoided. Unsaturated fats may make up up to 35% of the caloric content in the diet and can be found in foods like olive oil, fatty marine seafood from reputable sources, nuts, seeds, and avocados. Lean chicken, low-fat dairy products, lentils, fish, and shellfish are all excellent sources of protein.

Omega-3 fatty acids, particular minerals, antioxidant vitamins, and their importance in reducing oxidative stress should also be highlighted. Additionally, the prospective benefits of using supplements like carnitine and coenzyme Q10 in therapeutic approaches seem encouraging.

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Table 1. Key Attributes of a Diet That Promotes Fertility

Dietary Component/Items	Active Substances	Comments/Remarks
Oily sea fish	PUFA, omega-3 Fat-soluble vitamins A, D, E, K	Since fish and seafood are the primary dietary sources of DHA and EPA, including them in the diet may be linked to an improvement in semen quality. Fish are often polluted with neurotoxic chemicals like mercury.
Fruits and Vegetables	Antioxidants, folic acid, fibre, minerals	A diet centered around vegetables and fruits forms the foundation of nutrition models that promote overall health and are linked to enhanced semen quality and fertility. Opting for unprocessed vegetables and fruits is particularly beneficial. Scientific studies indicate that the presence of pesticide residues in fruits and vegetables might influence the positive effects of their consumption on semen quality.
Nuts, seeds	EFA's, fibre, tocopherols, phytosterols, polyphenols, minerals	Pick unroasted, unsalted nuts and seeds wherever possible. The incorporation of almonds in the diet may enhance the sperm's quality.
Whole-grain products	Fibre, zinc, magnesium	It is advised to restrict ingestion of foods manufactured with refined flour and to choose instead for whole-grain foods that are high in fiber.
Fat free dairy products	Calcium, a wholesome protein	Due to their decreased concentration of saturated fat, low-fat dairy products are advantageous. It is advantageous to choose low-fat dairy products, due to a lower saturated fat content. with vegetable oils containing unsaturated acid residues.

### Role of antioxidants

Despite inconsistent results from research studies, the significance of antioxidants in male fertility is still a fiercely debated subject. Oral antioxidant supplementation tends to enhance semen quality and reduce DNA damage, but there is little data to support its influence on successful pregnancies and live birth rates. Antioxidant supplementation may increase the live birth rate in infertile males, according

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to a number of randomized research, however caution is advised owing to the ambiguity and potential bias in these studies. Therefore, more comprehensive study is required to establish the effectiveness, safety, and suggested dosages of antioxidants.

Zinc, which is considerably abundant in seminal plasma and the prostate organ, is essential for male fertility. For sperm generation, morphology, count, and function as well as testicular growth and steroidogenesis, adequate zinc levels are necessary. Hypogonadism, undeveloped secondary sexual characteristics, oligospermia, asthenozoospermia, and azoospermia are all linked to zinc deficiency. Higher sperm count, motility, viability, and antioxidant activity are all related to optimal zinc concentrations in semen. Additionally, zinc is essential for preserving the DNA quality of sperm and safeguarding them from bacterial and chromosomal damage.

Selenium is a vital element that plays a critical role in supporting enzymatic antioxidant activity through its involvement in glutathione peroxidase. Both selenium deficiency and excess can have an impact on fertility and semen parameters, with infertile men frequently exhibiting lower selenium levels compared to the general population. Selenium plays a beneficial role in enhancing sperm motility and viability, safeguarding sperm DNA from oxidative stress, and is crucial for spermatogenesis. The testis contains the highest concentration of selenium, which is necessary for the proper development of selenoprotein P and glutathione peroxidase.

In addition to zinc and selenium, other antioxidants such as vitamin C, tocopherol (vitamin E), coenzyme Q10, lycopene, N-acetyl-cysteine (NAC), and omega-3 fatty acids demonstrate beneficial effects on semen quality. These antioxidants neutralize free radicals, reduce oxidative stress, strengthen the immune system, and enhance sperm parameters such as density, motility, morphology, DNA fragmentation, and hormonal levels. Combining multiple antioxidants in supplementation has shown positive results, and a diet rich in vegetables, fruits, and hazelnuts can contribute to higher antioxidant intake.

Magnesium and calcium are recommended to ensure normal spermatogenesis and sperm motility, while copper and manganese also play roles in sperm function and fertilization. However, excessive quantities of manganese and copper can have adverse effects on sperm.

### **Conclusion**

Overall, a diet rich in antioxidants, zinc, selenium, omega-3 fatty acids, and other essential nutrients appears to support male fertility and enhance semen quality. However, further research is necessary to establish optimal supplementation strategies, dosage recommendations, and the impact on pregnancy outcomes and live birth rates.

The quality of semen can be influenced by nutrition, having either positive or negative effects. It is recommended to include vegetables, fruits, salmon, seafood, nuts, seeds, whole-grain foods, poultry, and low-fat dairy products in your diet to promote healthy semen composition. On the other hand, a diet low in fruits, vegetables, and antioxidant-rich foods, combined with a high intake of calories,

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saturated and trans fats, limited consumption of salmon, and a high proportion of red and processed meat, can have adverse effects on semen quality and reduce male fertility.

To address male infertility induced by poor semen quality, it is crucial to make necessary lifestyle adjustments, particularly in terms of dietary choices.

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