



Review

# Mediterranean Diet and Male Fertility

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**Abstract:** Diet has an impact on male reproductive potential, but few studies have focused on the specific impact of food groups or dietary patterns on fertility. Male reproductive health, as indicated by improved semen parameters and increased chances of conceiving, is associated with the Mediterranean diet, while the Western diet is considered a risk factor for male infertility. The potential mechanisms that may explain the impact of these diets on semen quality are still largely unknown. However, numerous studies suggest that nutritional interventions are crucial for the preservation and improvement of male fertility. This review aims to summarize the most recent evidence on the influence of components of the Mediterranean diet on sperm parameters. Unlike other risk factors, dietary modulation represents a great opportunity for improving overall health and can also be an important tool in recommendations for male reproductive health.

**Keywords:** Mediterranean diet; male fertility; sperm quality parameters; nutrition

## 1. Introduction

In the past few decades, Western countries have seen a substantial increase in total calorie intake, added sugars, refined carbohydrates, fats, and red meat consumption [1]. This decline in diet quality has been associated with the worsening of human semen quality parameters among Western populations [2–4], which may result in fertility problems in the future [4].

Apart from the traditional risk factors (hormonal disorders, physical problems, chromosomal abnormalities, etc.), lifestyle factors, particularly diet, may have a critical influence on male fertility [5,6]. In fact, many studies have strongly associated diet composition with semen quality parameters, notably sperm count, concentration, and motility [5,7–10]. Unlike other risk factors, diet represents an interesting possibility for intervention as it is an important modifiable determinant of male fertility [11]. Adolescents are a particularly vulnerable population that could benefit the most from lifestyle intervention strategies [12]. All health promotion and disease prevention policies will also have a positive impact on their future reproductive health [12].

Several studies support the hypothesis that specific micronutrients and food compounds can affect semen quality parameters [5–7,13–16]. In recent years, studies have focused on the effects of dietary patterns. The traditional Mediterranean Diet (MedDiet), characterized by a high intake of vegetables, legumes, fruits, nuts, grains, fish, seafood, and olive oil, and moderate physical activity, has been shown to confer numerous and well-described health improvements, including on reproductive potential, mainly due to potent anti-inflammatory and antioxidant substances naturally present in these foods [17].

Previous research indicates that the adoption of MedDiet food patterns by men is linked to greater reproductive success [15,16,18–20]. Current evidence, based on observational epidemiological studies, shows that a high intake of fish and plant-based foods, such



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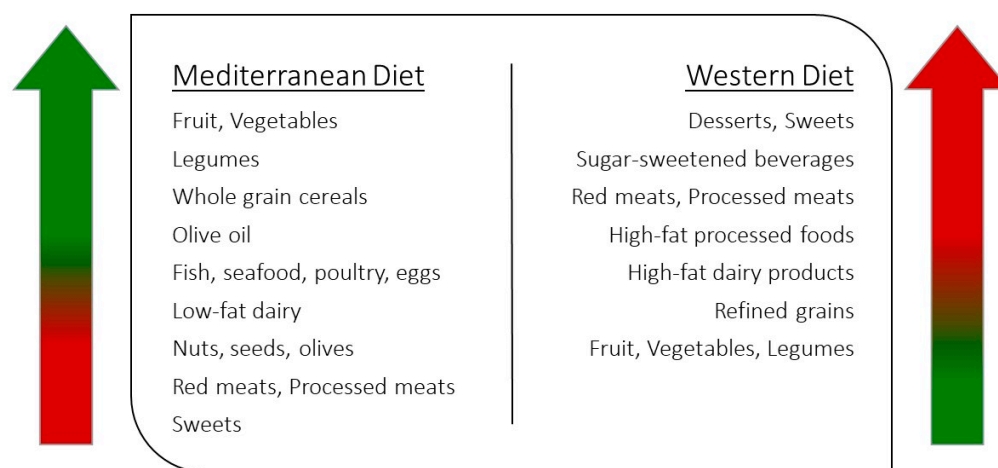
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as fruits, legumes, and whole grains, and a low intake of meat and processed foods are associated with semen quality parameters amelioration, although they do not consistently correlate to all semen variables [15,16,18–20].

While most dietary recommendations for health promotion are designed to prevent or modify the risk of cardiovascular disease and other major chronic diseases, it is unclear if they can also influence male reproductive potential. We aim to summarize the latest evidence concerning the impact of components of the MedDiet on sperm parameters, challenging its role as an essential tool in recommendations for male reproductive health.

## 2. Mediterranean Diet versus Western Dietary Pattern

The MedDiet encourages increased consumption of fruits, vegetables, whole grains, nuts, seafood, and low-fat dairy (Figure 1) [21]. This diet is a synonym of a restricted intake of simple carbohydrates, cholesterol, saturated and *trans* fats, and a higher intake of fiber, vitamins, minerals, and other non-nutritional components with potent antioxidant and anti-inflammatory properties [21].



**Figure 1.** Characteristics of Mediterranean and Western diets.

Cutillas-Tolín and col. (2015) [18] analyzed the relationship between the MedDiet and the Western diet with semen quality parameters in 209 young and healthy men (aged 18–23 years). The researchers found that men who adhered more closely to the MedDiet had normal total sperm count and were more likely to have normal body mass index values, be non-smokers, and have a more active lifestyle [18]. In contrast, among those who preferred a daily Western dietary pattern, low sperm concentration was observed, particularly in overweight and obese men [18]. Indeed, foods included in the Western-style diet (Figure 1), such as high-fat dairy, red meats, and processed meat products (sources of saturated fat and *trans* fatty acids, respectively), have been inversely related to overall sperm parameters and total sperm count [22,23].

Recently, Cao and col. (2022) [24] published a systematic review and meta-analysis that aimed to explore the effects of higher and lower consumption of healthy diets, including the MedDiet, on semen quality. They found that men with greater compliance to healthy diets had the greatest sperm concentration, progressive sperm motility, and total sperm count [24]. However, other parameters, such as sperm morphology, total sperm motility, and semen volume, seemed to be similar compared to men with the lowest ingestion of healthy diets [25].

The regular intake of sugar-sweetened beverages has been associated with weight gain and obesity, which in turn increase insulin resistance and negatively affect semen quality through increased oxidative stress [5]. Lower semen volume, sperm concentration, total sperm count, and total motility have been reported among sugar-sweetened beverage consumers [5]. Since artificially sweetened beverages are not associated with weight gain

and obesity itself, this type of beverage has become popular and frequently consumed in the last decades [5]. However, Meldgaard and col. (2022) [24] recently found that semen quality in young men was not significantly affected by the consumption of sugar-sweetened or artificially sweetened beverages. Nonetheless, the percentage of morphologically normal sperm was slightly lower among consumers of artificially sweetened beverages at least 3 days per week [24].

In a systematic review by Falsig and col. (2019) [26], the results from observational studies were found to be consistent with those from randomized controlled trials (RCTs) concerning the adoption of a healthy diet rich in omega-3 fatty acids (from fish and seafood) and improved semen parameters. Positive associations with omega-3 fatty acids were observed in the following parameters: reduced risk of asthenozoospermia; normal morphology; increased total sperm count, concentration, motility, and volume; and reduced sperm DNA fragmentation [26]. Additionally, some findings indicate that the consumption of foods rich in omega-3 fatty acids may also improve fecundity [27].

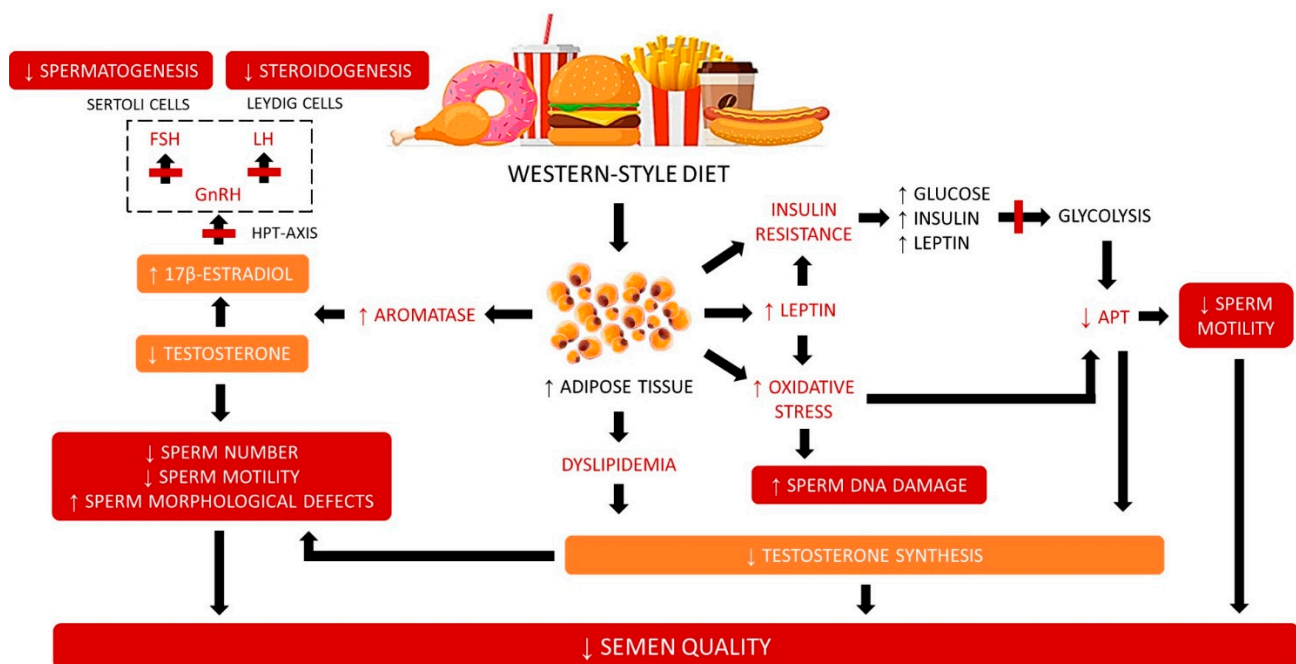
Fish and seafood are not the only sources of omega-3 fatty acids. Nuts, such as walnuts, hazelnuts, and almonds, are nutrient-dense foods traditionally present in the MedDiet, and are rich in omega-3 fatty acids, as well as vitamins C and E, selenium, and zinc [28]. Interestingly, in the FERTINUTS (*Effect of Nut Consumption on Semen Quality and Functionality in Healthy Males*) study, Salas-Huetos and col. (2018) [28] found that when young, healthy men were invited to consume a Western diet enriched with 60 g of nuts for 14 weeks, considerable improvements in total sperm count and vitality, as well as total and progressive motility and morphology of sperm were observed compared to a control group. Nut consumption was also associated with a significant reduction in sperm DNA fragmentation, which can justify these positive results in sperm parameters [28].

Over the last several decades, the Western diet has been the culprit for the growing rate of obesity, which has had a significant negative effect on fertility due to its impact on hormonal levels, sperm function, and gamete molecular composition (Figure 2) [1,11,16,29]. Despite the fact that a higher body mass index has been associated with compromised sperm production and quality [6,30], the molecular mechanisms underlying obesity and male infertility are still not totally understood [31]. Increased body fat mass has been related to impaired reproductive potential due to its effect on the molecular and physical structure of sperm [6,32,33]. Obese men are more likely to be infertile due to the larger proportion of DNA fragmentation, abnormal morphology, and low mitochondrial membrane potential, which have been linked to high levels of ROS [32,33]. Regular consumption of a Western diet is directly associated with the high prevalence of obesity and its comorbidities (such as insulin resistance and diabetes) and has also been related to low sperm quality or function [34,35]. For instance, high-energy and high-fat diets (particularly those higher in animal fat and processed foods) have been associated with testicular disruption and, thus, impairments in spermatogenesis [11].

The high proportion of adipose tissue is also associated with increased conversion of testosterone to estrogen (mainly through increased aromatase activity), decreased production of testosterone due to the increased secretion of leptin, and decreased gonadotrophin secretion (Figure 2) [36]. However, these conditions can potentially be reversed with diet- and exercise-induced weight loss [29,37]. Interestingly, weight-loss surgeries performed on morbidly obese men, despite inducing an increase in total testosterone and follicle-stimulating hormone levels, do not impact semen quality parameters [38]. Taken together, it seems that diet quality, but not total energy intake, may have a more noticeable impact on spermatogenesis [39].

There are many interesting interventional trials focused on the effect of increasing the intake of certain foods and/or administering specific nutritional supplements on semen quality parameters without other changes in dietary habits or lifestyle. Recently, Montano and col. (2022) [40] evaluated the outcomes of a dietary and exercise intervention on the semen quality of healthy, young, normal-weight men. The men randomly selected for the intervention group were invited to modify their habits in a relatively short time

(4 months), whereas men enrolled in the control group received only general recommendations concerning a healthy lifestyle [40]. The main findings of this randomized trial, known as the “Fertilità, Ambiente, alimentazione, STile di vita” (FASt) study, showed that a lifestyle intervention based on MedDiet principles and regular exercise practice led to an increase in sperm concentration, as well as higher total and progressive motility [40]. Additionally, the proportion of spermatozoa with abnormal morphology and the number of round cells were reduced in these men. Overall, the semen quality parameters of men who modified their lifestyle by adopting a healthy diet and exercising regularly improved significantly compared to those who only received generic health advice. The authors concluded that lifestyle interventions could be paramount in healthy young men for protecting and potentially enhancing semen quality [40].



**Figure 2.** Effects of Western-style diet on semen quality.

### 3. Mechanisms of Mediterranean Diet Effects on Semen Parameters

Adherence to the MedDiet pattern is associated with a diminished risk of low sperm concentration and total count, as previously mentioned. Although the biological mechanisms linking diet, sperm function, and fertility are not yet fully understood, potential mechanisms are discussed here.

MedDiet foods are naturally rich in nutrients with anti-inflammatory effects [41]. Chronic low-grade inflammation may affect reproduction through anatomical or functional changes in the male accessory gland and/or through direct negative effects on spermatozoa [41]. The association between adherence to the MedDiet and semen quality may also be mediated by increased intake of omega-3 fatty acids found in fish and fish oils [42], as well as in nuts [28]. Sperm and testicular cells, compared to other cells or tissues, have a higher concentration of long-chain polyunsaturated fatty acids (LC-PUFAs), particularly docosahexaenoic acid (DHA; 22:6 n-3) [26]. DHA is thought to play an important role in the regulation of membrane fluidity and spermatogenesis and is involved in acrosome reaction and sperm–oocyte fusion [26]. Several studies show that DHA levels in spermatozoa from asthenozoospermic and oligozoospermic men are significantly lower compared to normospermic men [26]. Seafood is also characterized by a high content of fat-soluble vitamins (vitamins A, D, E, and K), which play a crucial role in fertilization [27].

The typical foods of the MedDiet have a low content of saturated and *trans* fatty acids, two components that can trigger or worsen inflammation and thus affect semen

quality [43]. The intake of *trans* fatty acid-rich foods, such as processed and ultra-processed foods, has been associated with disruptions in testosterone levels, testicular function, and sperm cell membrane quality [44]. Low testosterone levels and lower testicular volume have been reported among unhealthy diet consumers [45]. Furthermore, both saturated and monounsaturated fatty acids content in sperm are negatively linked to sperm motility and sperm concentration, while spermatozoa and seminal plasma DHA content could be considered as predictors of cryopreservation success (sperm DHA were associated with sperm motility and viability after freezing/thawing) [45]. Considering this, MedDiet adoption should be considered to improve overall health and male fertility.

Greater adherence to the MedDiet is significantly associated with improved semen quality, higher sperm concentration, total sperm count, and total and progressive sperm motility [19,46–50], as well as lower DNA fragmentation [50]. These benefits of the MedDiet on semen features are believed to be due to the high intake of fruits and vegetables rich in antioxidant vitamins (such as beta-carotene and vitamins A, C, and E), minerals (such as magnesium), and polyphenols [51]. As sperm membranes are highly sensitive to oxidative damage caused by reactive oxygen species (ROS), the benefit of this diet on semen quality may be due to the greater intake of foods naturally rich in antioxidants and carotenoids [51].

Antioxidants found in plant-based foods can play a significant role in influencing semen quality. Indeed, antioxidants are important for reproductive health, as they protect against excessive production of ROS, which can harm sperm DNA integrity, sperm cell plasma membranes, sperm quantity and function, such as motility, and sperm–oocyte fusion [52,53]. Moreover, these substances also help to prevent sperm agglutination by neutralization of hydroxyl, superoxide, and hydrogen peroxide radicals [53]. The MedDiet, which emphasizes a higher plant-food intake rich in antioxidants rather than meat and meat products, can have favorable effects on semen indicators. For instance, carotenoids have been associated with higher sperm motility in young, healthy males [51].

Men who consume a diet high in antioxidants and folate have been found to have better semen quality and less DNA damage in spermatozoa. Dark green leafy vegetables are a good source of folate, which is essential for spermatogenesis, DNA and protein synthesis, and DNA and protein methylation processes. Seminal plasma with low folate concentration is linked to sperm DNA damage, as folate shortage increases DNA fragility due to the misincorporation of uracil instead of thymine. If the removal of the misincorporated uracil fails, it can result in double-strand breaks that cause chromosome instability during normal repair processes. Folate deficiency also reduces the supply of methyl groups, which play an important role in DNA protection against damaging exposures [52]. Higher intakes of folate-rich foods, such as fruits and vegetables, have been linked to decreased DNA fragmentation and enhanced motility [20].

Berries, such as blueberries, strawberries, and raspberries, as well as grapes and red wine, are high in fiber, vitamin C, and antioxidant polyphenols. Resveratrol is a potent polyphenol found in these foods, which are typically included in the MedDiet. Several studies have demonstrated that resveratrol may be beneficial for human male fertility due to its proven antioxidant effects and positive effects on several enzymatic pathways [54]. Although the ideal concentration of daily resveratrol consumption and/or supplementation is still unknown, it is consensual that it has beneficial effects on spermatogenesis and contributes to better sperm parameters [55], particularly in obese men [56].

In recent years, multiple studies have emerged concerning the effects of gut microbiota on general health, specifically on fertility. It is well recognized that diet largely affects gut microbiota composition [56–58]. High intake of fat and/or simple sugars, as seen in Western-style diets, are two of the primary causes of intestinal dysbiosis. This condition results in a quantitative and qualitative imbalance of intestinal microbiota that disrupts the intestinal barrier [56]. The increased permeability of the intestinal barrier promotes chronic systemic inflammation, which further contributes to obesity and several metabolic diseases [58]. According to recent animal [59,60] and human [61] studies, a high-fat diet

may also lower sperm quality by altering the gut microbiota, while modulating the gut microbiota may increase sperm quality.

#### 4. Nutritional Supplements

According to a systematic review by Falsig and col. (2019) [26], omega-3 supplements and dietary intake of omega-3 may improve semen quality parameters in infertile men and men from couples seeking fertility treatment. Supplementation with omega-3 capsules containing DHA was found to increase sperm motility [62], reduce sperm DNA fragmentation [63], as well as increase sperm concentration, total sperm count, and normal morphology [18,64]. However, further research is required to fully clarify the effect of omega-3 on semen quality, and studies with fecundity as an endpoint are needed. Nevertheless, the available results suggest that supplementation or a high intake of omega-3 fatty acids may be recommended to infertile men for improving semen quality parameters [62–64]. A considerable number of infertile men with idiopathic oligoasthenoteratozoospermia might benefit from administration of omega-3 fatty acids (DHA + Eicosapentaenoic acid, EPA, 20:5n-3) (1.84 g/d for 32 weeks), achieving greater antioxidant activity in human seminal fluid, resulting in enhanced sperm count, motility, and morphology [65,66].

Recently, a meta-analysis reported a significant enhancement of sperm motility together with an increased concentration of seminal DHA for infertile men supplemented with omega-3 fatty acids (DHA or EPA treatments either alone or in combination with other micronutrients) [42]. Furthermore, another meta-analysis of 16 RCTs showed that semen parameters improve after omega-3 fatty acids supplementation and decrease with a diet rich in saturated and *trans* fatty acids [67]. When taken together, these findings may confirm the relevant role of a controlled fatty acids diet in male fertility. However, more studies are needed as the available RCTs on this topic have severe limitations, such as a relatively low number of participants and the existence of different treatment regimens concerning the dose and duration of follow-up.

Regarding micronutrient supplementation, it is important to consider that the administration of one micronutrient may affect the bioavailability of others. For instance, iron supplements may increase urinary excretion of zinc. This is particularly true for divalent cations, given their role in oxidative stress protection. Although ROS have negative effects on spermatogenesis, RCTs of antioxidants versus placebos have been disappointing. Nevertheless, it has been demonstrated that serum antioxidant status is directly associated with sperm concentration, motility, and normal morphology [68,69].

A few years ago, the effects of specific nutrients and nutritional supplements on male infertility were reviewed [70]. Oral complexes of selenium; selenium plus vitamin A; vitamin C; vitamin E; L-carnitine plus L-acetylcarnitine; beta-carotene, alpha-tocopherol, and arachidonic acid; coenzyme Q10; clomiphene citrate plus vitamin E; EPA plus DHA; and ubiquinol, were administered to improve sperm quality (sperm concentration, motility, and morphology), or to prevent sperm DNA fragmentation. Only the studies that included supplements of carnitine, coenzyme Q10, and selenium showed some beneficial effects on sperm parameters, even though the potential underlying biological mechanisms were not addressed [70].

Antioxidant supplements have shown some potential in treating idiopathic oxidative stress in spermatozoa [71,72]; however, the safety of these dietary supplements is unclear, especially at higher doses, so the possible risks for consumers are unknown. Interestingly, a higher intake of foods rich in antioxidants has been associated with better sperm quality [72], whereas antioxidant supplements have not [73].

Vitamin and antioxidant supplements have been shown to be effective in improving male fertility, with a 26% increase in conception rate compared to 11% for placebo or no therapy [74]. As a result, given the increasing popularity of nutritional supplements in Western countries, studying the role that dietary compounds play in male infertility is a promising area of research. In this context, to provide men with safe and reliable recommendations, it is mandatory to conduct large and well-conducted RCTs.

## 5. The Dark Side

The consumption of plant-based foods represents several well-recognized health benefits. However, we cannot ignore the numerous chemical substances used in intensive agriculture, particularly those used for pest control [75]. Pesticides are potent endocrine disruptors with several effects on male fertility [76]. Although the processes by which pesticides disrupt male reproductive function are still unclear, pesticide exposure is known to cause hormone imbalances, germ cell death, testicular atrophy, and reduced spermatogenesis [77]. Evidence suggests that high consumption of foods of plant origin with high levels of agrototoxic residues is associated with a lower total sperm count and motility, as well as a lower percentage of morphologically normal sperm [78]. Nevertheless, the richness of fruits and vegetables in some antioxidant substances, such as flavonoids, can mitigate the effects of pollutants and/or promote their elimination from tissues and fluids [79]. Interestingly, a recent RTC conducted on healthy young men from a highly polluted area of Italy has demonstrated positive effects of the MedDiet and regular physical activity on semen quality [40].

Fish and seafood are excellent sources of omega-3 fatty acids. However, it is important to acknowledge that the consumption of fish, especially shark, swordfish, king mackerel, tilefish, and tuna, is the primary source of methylmercury in the general population [80]. In fact, methylmercury is the most common organic mercury compound found in the environment, and it has been shown to have neurologic and reproductive detrimental effects. However, it is still unclear how the consumption of fish contaminated by methylmercury affects semen quality parameters [80].

The MedDiet pattern includes a moderate amount of alcohol consumption, particularly red wine, during meals. Red wine is particularly rich in resveratrol, a polyphenol with potent antioxidant properties. Nevertheless, chronic alcohol consumption has been linked to a decline in sperm quality, with a dose-dependent effect on sperm volume, motility, and morphology [47,81,82]. Alcohol intake affects spermatogenesis at both the pituitary and testes levels [8]. Alcohol suppresses the hypothalamic-pituitary-testis (HPT) axis and has direct toxic effects on Leydig and Sertoli cells [8], leading to progressive testicular damage [83]. Although the amount of alcohol that increases the risk of male infertility remains to be determined, abstinence from alcohol is known to restore alcohol-associated azoospermia [82].

Caffeine and theobromine are methylxanthine derivatives. The main sources of caffeine consumption are coffee, tea, and colas, as well as energy drinks and chocolate [84]. Theobromine is found in chocolate, tea leaves, and the cola nut. Although the traditional MedDiet does not include ingestion of these foods, they are widely consumed worldwide. There are conflicting reports regarding the relationship between caffeine intake and male infertility [6]. Albeit caffeine consumption did not have a noticeable effect on sperm counts (even when exceeding 800 mg/day, equivalent to at least 4 cups of coffee daily), coffee drinking was found to reduce sperm motility, and a high intake of colas significantly affected sperm quality markers [47,85]. Similarly, the systematic review conducted by Ricci and col. [13] concluded that semen parameters were altered by caffeine-containing soft drinks, a finding that was not observed with caffeine from coffee and tea. These findings suggest that low-to-moderate tea and coffee intake should not have a deleterious influence on sperm health [86,87].

## 6. Critical Analysis

The MedDiet encompasses more than just a food pattern. It is a healthy lifestyle that includes cuisine, agriculture, cultural heritage, and social habits related to food (such as commensality and conviviality), as well as encouraging regular exercise [88]. The sedentary behavior observed in Western societies and Western-style diet consumers is associated with reduced exposure to sunlight and an increased risk of vitamin D deficiency. Currently, it is widely accepted that vitamin D is not only crucial for bone metabolism, but it may also play a role in male fertility [88]. Although higher serum levels of this vitamin have

been positively associated with sperm motility, indicating that it may contribute to optimal sperm function [88], Amini and col. (2020) [89] found no benefits of oral vitamin D supplementation on sperm cell quality in infertile men. Further studies in this field are necessary. For now, the evidence concerning vitamin D supplementation and sperm quality seems to be only effective in cases of insufficiency [89].

The adoption of the MedDiet pattern may pose challenges in non-Mediterranean countries due to poor availability and accessibility to MedDiet-specific foods [90]. However, it is important to note that the consumption of health-promoting foods, such as legumes, vegetables, fruits, and whole grains, and the reduced intake of red meat, processed meats, high-fat dairy, sugars, caffeine, and alcohol, is common in other healthy patterns, including the so-called *Prudent* diet and *DASH* (*Dietary Approaches to Stopping Hypertension*) [90]. These diets share a wealth of nutrients and non-nutritional compounds associated with well-being, disease prevention, and fertility [91].

Another important consideration is the use of nutritional supplements, either as single nutrients or as a mix of nutrients. The overall diet, which includes diverse nutrients and bioactive non-nutrient plant compounds, appears to be a better predictor of health than nutrients alone. Nutritional supplements should only be prescribed in situations of increased nutritional needs or proven nutritional insufficiency. This could explain why the MedDiet pattern is more often associated with better semen quality than nutritional supplements.

A Western diet has been associated with an increased risk of metabolic diseases, atherosclerosis, neurodegeneration, cancer, and infertility [6,11,29,65,67]. Dietary changes may be helpful in improving male fertility and fecundability. Healthy diets, such as MedDiet, which is rich in omega-3 fatty acids, antioxidants, and vitamins, and low in *trans* and saturated fatty acids, have been associated with better semen quality [92]. In fact, diets that include fish, shellfish, seafood, poultry, cereals, vegetables and fruits, and low-fat dairy products, have more benefits to male reproductive health than diets that include red and processed meats, full-fat dairy products, sugar, coffee, and alcohol [11]. It is also important to consider the balance between omega-3 and omega-6 fatty acids. An excessive intake of omega-6 may have negative effects on fertility since they are prone to causing mild inflammation and oxidative stress [93].

It is essential to underscore some limitations of the available studies. Firstly, it is not currently possible to predict if the beneficial effects of the MedDiet on semen quality can lead to a higher probability of successful conception. Additionally, most of the conclusions from the studies included herein are based on results from only one semen sample from each participant, which, in turn, were selected from *in vitro* fertilization clinics. Since these men may have distinct health problems, be overweight, and do not exercise, we consider that some findings may not be applicable to a healthy population. Finally, men who adhere more closely to the MedDiet generally have a healthier profile.

As far as we know, it is currently not possible to establish a direct causal relationship between adherence to the MedDiet and improved semen quality. It is possible that this type of healthy diet is associated with an overall healthy lifestyle, which may have a positive impact on semen quality. Furthermore, most studies that have investigated the impact of a healthy diet on semen quality have only assessed sperm parameters and antioxidant capacity, which are limited in their ability to determine the fertility potential of an individual. Therefore, it would be valuable to investigate if the improved semen quality parameters translated into enhanced fecundity and successful pregnancies. We believe that the associations presented here require further confirmation in larger scale prospective cohort studies and well-designed RCTs.

The MedDiet is undoubtedly a globally recognized healthy food pattern. According to the *Developmental Origins of Health and Disease* (DOHaD) paradigm, the exposition to environmental factors, including diet, during early life may impact adult health and increase the risk of chronic noncommunicable diseases [94]. Therefore, the adoption of a healthy diet and lifestyle would not only benefit male fertility but also provide an excellent



opportunity for men to maximize sperm epigenetic integrity and optimize the health of their offspring.

## 7. Conclusions and Future Directions

The association between the healthy MedDiet pattern and sperm quality is not yet fully understood. However, it is indisputable that the amount and quality of the nutrients can affect sperm quality parameters. The best example of this is the impact of dietary fat composition. It is well-recognized that diets high in saturated fats and low in polyunsaturated fatty acids or with an unbalanced omega-6/omega-3 ratio can have a negative effect on sperm quality.

Our analysis contributes significantly to the field of nutrition and male reproduction. However, further investigation is needed to uncover the molecular mechanisms underlying the action of nutrients and natural compounds on sperm quality, which can help the development of new interventional strategies.

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