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Dietary Nutrients and Male Infertility: Review of Current Evidence

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Abstract

Lifestyle factors and nutritional status are regarded as critical determinants of normal reproductive function. Hence, the role of dietary nutrients has attracted the attention of researchers to the extent that some studies have addressed the effects of diet on the risk of male infertility. This study aimed to summarize the literature regarding the association between various dietary factors and male infertility. Literature searching for studies on male infertility and nutrition, published between January 1982 and May 2015, was performed using PubMed and Scopus databases. The bibliographies of included studies were also searched for additional references. About 65 articles were identified and after the elimination of irrelevant studies, 35 related studies available for review were examined. Studies have indicated that in men with idiopathic infertility, omega-3 intervention resulted in significant improvement in total sperm count as well as sperm cell density. Moreover, several studies have shown that higher intake of poultry, cereals, fruit and vegetables may play a beneficial role in male infertility; although, some studies have not attained such results. Taken as a whole, studies demonstrated that food consumption may play a major role in preventing or facilitating male infertility. Further studies are needed to clarify this association.**[GMJ.2015;4(4):123-29]**

Keywords: Nutrition; Spermatogenesis; Nutrient; Sperm Quality; Male Infertility

Introduction

Infertility is a condition which is defined as one-year unsuccessful attempt to conceive[1].Based on the reports by World Health Organization(WHO),at least 60–80 million couples are suffering from infertility worldwide[2].A male partner factor plays a role in about 40% of infertility cases[2].A reduction in male fertility has been observed over the recent decades[3].Sperm density has dropped by 40% during the past 50 years[4].Studies suggested that congenital and acquired urogenital abnormalities, infections of genital tract, increased scrotal temperature (Varicocele),endocrine disturbances, genetic abnormalities and immunological factors might lead to a reduction in male fertility[5].However, no causal factor is reported in 60-75% of cases, the condition that defined as idiopathic male infertility[6]. These men have no previous history associated with fertility problems and present with normal findings on physical examination and endocrine laboratory testing [7]. Semen analysis demonstrates a decreased number of spermatozoa (oligozoospermia)

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defined as <20 million spermatozoa/mL, reduced motility (asthenozoospermia) defined as <50% motile spermatozoa and various abnormal forms on morphological examination (teratozoospermia) defined as <14% normal forms [6]. These abnormalities usually occur together and are described as the oligoastheno-teratozoospermia (OAT) syndrome [6]. Infertility caused by idiopathic oligoastheno-teratozoospermia syndrome without any female factor, constitutes one of the greatest patient groups in the daily practice of urologists [8]. In spite of major advances in the field of infertility, many cases of male infertility have been diagnosed as idiopathic with no particular treatment [8]. However, it has been suggested that chronic stress, endocrine disruption due to environmental pollution, reactive oxygen species, genetic abnormalities as well as occupational and lifestyle factors may be particularly linked with pathophysiology of infertility [9]. Eating habits, as principle lifestyle factors, in terms of both macro- and micro-nutrients intake have major effects on normal reproductive function [9, 10]. Due to swift changes in eating behavior, the expansion of unhealthy dietary patterns, specifically higher intakes of saturated fat, trans fatty acids and sodium and lower consumption of antioxidant-rich foods such as fruit and vegetables, has an upward trend in reproductive age people [11]. Meanwhile, several studies indicate that higher consumption of fruit, vegetables, poultry, sea foods, skim milk and shellfish as well as lower intake of full-fat dairy, sweets and processed meat specifically with high-saturated fat foods are linked with higher sperm quality [2, 12]. The aim of this review was to summarize the evidence from research articles that have examined the potential effects of various dietary factors on male reproductive function and fertility.

Materials and Methods

In order to examine the relationship between dietary nutrients and male infertility, articles with case-control, descriptive, cohort and interventional (clinical trials) design published between January 1982 and May 2015, were accessed through PubMed and Scopus databases using keywords such as "food groups", "spermatogenesis", "macronutrient", "sperm quality" and "male infertility". The bibliographies of target studies were searched for additional references. The authors independently screened the titles, abstracts and key words of each searched article for potentially eligible studies. The inclusion criteria were animal, intervention, observational studies and appropriate comparison group. The exclusion criteria were poorly defined comparison group and inaccessibility to the full-text. A total of 65 studies were found and screened, and based on our defined criteria, 35 eligible publications were used for data abstraction.

Dietary Fat and Semen Quality

More than 33% of daily caloric intake of human diet in most parts of the world comprises of fats and oils together [13]. Emerging evidence suggests that dietary fatty acids (FAs) may have considerable effects on male fertility [14, 15]. Three types of natural FAs include saturated, monounsaturated and polyunsaturated. Polyunsaturated fatty acids (PUFAs) cannot be synthesized by human body and are absolutely needed for numerous processes including growth, reproduction, vision and brain development; hence, they are regarded as essential fatty acids [16]. The mechanism through which spermatogenesis is linked with omega-3 and omega-6 PUFAs level is defined by the presence of these fatty acids in the spermatozoa cell membrane [16]. The positive outcome of spermatozoa fertilization is associated with the lipids of the spermatozoa membrane [17]. A study by Conquer *et al*. reported that Docosahexanoic acid (DHA) and oleic acid levels of spermatozoa from patients suffering from asthenozoospermia were lower and higher, respectively as compared to control group [18]. Another case-control study on idiopathic infertile men and healthy control group revealed that blood and spermatozoa levels of omega-3 PUFAs were significantly higher in fertile men in comparison with their infertile counterparts. Moreover, serum omega-6 to omega-3 PUFAs proportion was considerably lower in fertile individuals [8]. Attamen *et al*. investigated the association between dietary fats and semen quality in 99 men [19]. The study reported that 5% increase in total fat energy intake led to an 18% lower number of sperms. Similarly, substitution of 5% carbohydrate energy with 5% saturated fatty acids energy intake resulted in a 38% lower total sperm count while no relationship was observed regarding the similar 5% increase consumption of MUFA or PUFA at the expense of carbohydrate. A randomized trial of 238 infertile men suffering from idiopathic OAT with a daily intake of 1.48gr eicosapentanoic acid (EPA) and DHA or placebo were studied in a period of 32 weeks [8]. The omega-3 group experienced a significant improvement in total sperm count as well as sperm cell density. On the same line with these findings, in another clinical trial which was conducted on 22 patients with asthenozoospermic infertility, 465 mg of DHA and 600 IU of vitamin E were supplemented for 12 weeks; while, the control group took a placebo twice daily [20]. The authors reported that total sperm count, sperm concentration, percentage of motile sperms and percentage of motile sperms with straight direction enhanced in the intervention group in comparison with their control counterparts. Nevertheless, no statistically significant change was observed regarding sperm morphology and vitality in the intervention group. In contrast, in a randomized trial conducted on 28 Canadian asthenozoospermia, participants were divided into three groups including placebo, 400 or 800 mg of DHA for a period of 3 months. No significant improvement was observed with regards to the sperm motility or concentration [21]. Differences in the patient population, omega-3 fatty acid dose and duration of use, background fatty acid intake and involvement of unspecified amounts of omega-6 fatty acid such as corn oil in placebo may be the causes of differences across the aforementioned studies [19].

Taken as a whole, the findings of different studies revealed that fatty acid intake might be involved in male fertility disorders. Moreover, some fatty acid supplementation may improve this condition. Nevertheless, more randomized controlled trials are needed to investigate the efficacy of supplementation with specific fatty acids in male fertility disorders.

Dietary Protein Intake and Male Infertility

Some studies have investigated the relationship between different dietary sources of protein with male infertility. Swan *et al*. reported that maternal beef intake as well as xenobiotics [anabolic steroids] in beef resulted in an alteration in male fetus' development in utero and had adverse side effects on his reproductive capacity [22]. Sperm concentration was negatively associated with the mother's beef weekly consumption. In sons of "high beef consumer" (>7 beef meals per week) sperm concentration was diminished by 24.3% in comparison with men whose mothers consumed less beef. Likewise, an observational study which was conducted on two hundred fifty male patients undergoing ICSI cycles reported that meat consumption was significantly higher in infertile cases compared to healthy counterparts. Similar association was reported regarding higher intake of meat processed foods (sausages and others) with poor semen quality [23]. Similar findings were reported by a case-control study which was conducted on 72 asthenozoospermic men and 169 normozoospermic individuals [2]. The study showed that the odds of asthenozoospermia were 2.03 times in the highest fertile processed meat consumers. Additionally, for those in the highest fertile of poultry intake the odds of asthenozoospermia were 0.47 lower. Similarly, an observational study which was done on two hundred fifty male patients undergoing intra-cytoplasmic sperm injection reported that red meat intake was negatively related to implantation rate [12]. In contrast, Vujkovic *et al*. reported that men sticking to traditional Dutch dietary pattern [high in meat products] had higher sperm concentration in comparison with the men who were adhering to a diet with high intake fish [24].

Several studies evaluated the effects of soy food consumption on male infertility [25]. While soy food is regarded as a vegetable source of protein, some data have indicated that it adversely affects sperm parameters due to its high content of isoflavone [25]. Isoflavones are polyphenolic compounds with estrogenic activity that are derived from plants and found considerably in soy beans and also soy-derived products [26]. Plant phytoestrogens including genistein and daidzein can bind weakly to estrogen receptors α and β and are able to induce weak-estrogenic and anti-estrogenic actions in mammalian tissues [27]. In addition, isoflavones have been linked with male reproductive disorders in mammals including impaired development of reproductive organs, particularly following intrauterine exposure [28]. Data investigating the effects of phytoestrogens in male infertility is scarce [29]. In theory, it has been indicated that exposure to high concentrations of any exogenous estrogen might lead to alterations in gonadotrophin levels as well as in the function of reproductive system [30]. Besides, sexual impotence was reported in males occupationally exposed to synthetic estrogens in pharmaceutical industry [30, 31], and also diethylstilbestrol exposure is associated with reproductive dysfunction [31, 32]. In one study, consumption of 15 soy-based foods in the past 3 months was evaluated in 99 male partners suffering from infertility [25]. The authors reported that soy food consumption was negatively related to sperm concentration. Moreover, men who were in the highest category of soy food consumption had 41 million sperm per mL less than those who did not eat soy foods.

To sum up, several studies indicated that protein intake may be associated with developing male fertility disorders. In addition, some sources of protein such as soy may adversely affect this condition. Although, there have been no long-term studies in which phytoestrogen effects, either beneficial or adverse, have been rigorously investigated. This may be because of the fact that phytoestrogen-rich diets have been the staple in Eastern populations for hundreds of years with no documented toxic effects [33]. Nevertheless, more research is needed in order to investigate the association between specific protein sources with male fertility disorders.

Carbohydrate Intake and Male Infertility

Little is known about how carbohydrates may influence male reproductive potential. Data investigating the association between carbohydrate intake and male infertility is insufficient. An observational study revealed that consumption of cereal and fruit was positively correlated with semen quality [23]. Moreover, one case-control study conducted on 30 men suffering from poor semen quality and 31 healthy counterparts reported that the control group had higher intake of raw or cooked vegetables (especially lettuce and tomato) and fruit (particularly apricot and peach); whereas, intake of potato was higher in the cases [12]. Moreover, Eslamian *et al*. reported that men in the highest tertile of total fruit and vegetable intake had lower risks of asthenozoospermia [2]. In order to further investigate the protective role of fruit and vegetables, the authors analyzed the association between asthenozoospermia and different fruit and vegetables subgroups independently, and found that orange intake was negatively related to the risk of asthenozoospermia. Regarding vegetable consumption, increasing intake of dark green vegetables as well as tomatoes were linked with a lower risk of asthenozoospermia. Similarly, a poster communication presented to the American Society of Reproductive Medicine (ASRM) 26nd Annual Meeting in New Orleans in 2006 revealed that the proportion of men with low fruit and vegetable intake (<5 servings/day) was higher among infertile men than in controls. In that study, the lowest intake of dietary antioxidants had the lowest sperm motility [34]. Furthermore, a cross-sectional study called “Rochester Young Men’s Study” which was conducted on 188 men between the age of 18-22 investigated the association between different dietary patterns and semen parameters in young men [35]. Diet was assessed through food frequency questionnaire and dietary patterns were identified by factor analysis. The study reported that two dietary patterns [Western and Prudent] were identified. The ‘Western’ pattern defined by high intake of red and processed meat, refined grains, pizza, snacks, high-energy drinks and sweets; while, the ‘Prudent’ pattern is defined by high intake of fish, chicken, fruit, vegetables, cruciferous vegetables, tomatoes, leafy green vegetables, legumes and whole grains. The Prudent pattern was positively correlated with percentage of progressively motile sperm in multivariate models. Men in the highest

quartile of the prudent diet had 11.3% higher progressively motile sperm in comparison with men in the lowest quartile. However, the prudent pattern had no significant correlation with sperm concentration and morphology. Besides, the Western pattern was not related to any semen parameter. In contrast, in an observational study of 250 men undergoing ICSI, sperm motility was positively influenced by consumption of fruit and cereals [23].
Several observational and experimental studies have shown that fruit and vegetables are great sources of vitamin B6, folate and antioxidants in particular beta carotene, vitamin C and E, all of which are associated with improved sperm motility and other semen parameters such as sperm counts and morphology among both fertile and infertile. Moreover, fruit and vegetables are regarded as major sources of fiber intake which can decrease the plasma levels of estrogen via binding directly to unconjugated estrogens [36].

Conclusion

Taking aforementioned studies in to account, it can be concluded that the intake of saturated fat, processed meats, beef and soy food may be linked with male infertility; while, it has been suggested that higher consumption of MUFA, PUFA, poultry, fish, grains, vegetable and fruit are negatively related to male infertility; however, the results of the conducted studies are inconclusive and thus, more research is needed to investigate the influence and effect of dietary nutrients on reproduction and fertility in men.

Conflict of Interest

There is no conflict of interest in this manuscript.

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