Lifestyle, Environment, and Male Reproductive Health

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KEYWORDS

• Lifestyle • Male fertility • Environment • Reproduction • Semen analysis • Sperm parameters

KEY POINTS

- Trends that may negatively affect male fertility include increased cell phone use, obesity rates, opioid and marijuana use, and global surface temperature.
- Trends that may positively affect male fertility include decreased cigarette use, alcohol consumption, and airborne pollution levels.
- It is important for providers and patients to recognize and manage modifiable risk factors that can improve fertility potential for men.

INTRODUCTION

Reports of decreasing semen quality have prompted interest in the potential impact of environment and lifestyle on male reproductive potential. Over the past 40 years there have been dramatic changes in factors that have been potentially associated with changes in semen parameters. These factors include the introduction and rapid growth of cell phone use, a steep increase in consumption of opioids and marijuana,[1] and the increase in the worldwide population of cigarette smokers.[2] Moreover, obesity rates have rapidly increased[3] and physical activity rates and levels of environmental pollution have decreased.[4] Meanwhile, global surface temperatures have increased substantially.[5]

This article reviews the putative effects that personal health factors (diet, exercise, obesity, and psychological stress), substances of abuse (alcohol, cigarettes, marijuana, anabolic steroids, and opiates), and environmental factors (radiofrequency electromagnetic radiation, pollution, and heat) may have on semen parameters and male fertility. It also reviews trends over time for each factor and extrapolates to make predictions regarding the likely impact of these factors on male fertility 20 years from now.

PERSONAL HEALTH FACTORS

Several factors relating to general health and well-being have been extensively studied for their effects on male reproductive potential, including diet, exercise, obesity, and psychological stress.

Diet

Evidence suggests that male fertility (as well as female fertility) is decreased by men being either overweight or underweight (as defined by body mass index [BMI]>25 kg/m^2 and BMI<20 kg/m^2, respectively).[6] Healthy diet and regular exercise are therefore both recommended to maintain BMI between 20 and 25 kg/m^2.

Dietary fat has been shown to adversely affect semen quantity and quality.[7] A recent study of 222 healthy men recorded diet, semen analysis (SA), physical examination, and BMI. Diets categorized as high in fish, fruit, vegetables, legumes, and

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Urol Clin N Am 41 (2014) 55–66
http://dx.doi.org/10.1016/j.ucl.2013.08.017

whole grains were associated with significantly better sperm motility compared with diets categorized as high in red meat, processed meat, pizza, sugary drinks, and sweets. Other semen parameters were similar between groups. A similar small study of 30 infertile men who presented to a reproduction clinic found that these men had diets lower in fruits and vegetables, and higher in red meat and milk intake, compared with fertile controls.[8]

To further define the relationship of fat intake with decreased SA parameters, Attaman and colleagues[9] reported that men with high dietary saturated fat had decreased total sperm count and sperm density. However, omega-3 fats were shown to be positively correlated with healthy sperm morphology. More recent data have confirmed that omega-3, as well as omega-6, fatty acid intake is associated with improved total sperm count, semen motility, and morphology.[10]

In addition to dietary fat causing adverse semen parameters, reactive oxygen species (ROS) have been reported to decrease sperm-oocyte fusion and loss of semen motility. A 2010 meta-analysis reviewed 17 randomized trials of oral antioxidant supplementation (vitamins C and E, zinc, selenium, folate, carnitine, and carotenoids) on pregnancy rate and semen parameters. Most of the included studies (82%) showed either or both of an increase in sperm quality or pregnancy rates after oral induction of antioxidant therapy.[11] Specific effective antioxidants include carnitine, vitamin C, glutathione, selenium, and coenzyme Q10.[12]

Studies on the effect of caffeine on fertility reach varied conclusions. A large Danish study of more than 2500 men correlated caffeine intake with semen quality and found that high caffeine intake (defined as >800 mg/d) was associated with decreased sperm concentration and total sperm count compared with non–caffeine drinkers.[13]

Phytoestrogens or xenoestrogens are plant-derived nonsteroidal compounds that can mimic human estradiol (E2) and bind to estrogen receptors.[14] Soy, legumes, and soy-based foods such as tofu, soya beans, oils, and seeds have been shown to adversely affect multiple SA parameters and spermatogenesis.[15] In contrast, another study found that low or high intake of soy protein had no effects on semen parameters.[16] The paucity of well-designed human studies on male infertility in relation to phytoestrogens makes drawing conclusions difficult.

Exercise

As noted earlier, maintaining a BMI between 20 and 25 kg/m^2 is recommended to maintain optimal male fertility potential. Regular exercise is important, along with healthy diet, to prevent overweight or underweight body habitus. In addition to maintaining an optimal BMI, physical exertion has also been shown to have a relationship with testosterone (T) levels, thereby indirectly relating to fertility.

An observational study showed that moderately physically active men had significantly increased follicle-stimulating hormone (FSH), luteinizing hormone (LH), and T levels compared with sedentary controls.[17] This finding is expected, given that high T levels have been widely associated with increased energy and muscle strength. However, some reports have found that moderate-intensity endurance training results in increased free and total T levels in young healthy men shortly after exertion.[18,19] Other studies have found that there is no T level increase following exercise when corrected for exercise-induced increases in plasma levels.[20,21] Studies are needed to determine whether exercise yields increases in T and FSH on a longer-term basis.

In contrast with the unclear impact of moderate exercise, data suggest that vigorous exercise results in decreased T levels. Steinacker and colleagues[22] found that competitive rowers had unexpectedly low T levels. Another study of competitive athletes found that doubling the distance of cycling and running for 2 weeks resulted in a 17% decline in serum T concentration.[23] High-intensity endurance runners (>160 km [100 miles] per week) had a 31% reduction in free and total serum T after 2 weeks of unusually vigorous training and, similarly, another study showed that athletes' T levels significantly decreased after their training intensity was doubled over short periods of time.[24,25] In addition, a randomized controlled study of long-term endurance treadmill use on the hypothalamus-pituitary-testis (HPT) axis randomized 286 men to either moderate or intensive exercise groups. There was a significant decrease in LH, FSH, and T concentrations in the high-intensity group as well as decreased semen motility, density, and morphology.[26]

Obesity

The rate of obesity in reproductive-aged men has tripled in the past 30 years; during the same time period there has been a concomitant increase in male infertility.[3] However, no definitive relationship between the two entities exists. Controlled studies have reported conflicting results concerning the relationship between obesity and fertility potential. Although one study of 2139 men observed no reduction in sperm count among obese men compared with normal-weight controls[27] and