Influence and possible consequences of exogenous factors on male fertility

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ABSTRACT
Infertility is one of the most challenging experiences a couple can have. It has been found that male infertility encompasses of about 50% among all infertile cases across the globe. During the clinical assessment of an infertile male, many factors need to be considered as probable contributors. In addition to endogenous factors, numerous exogenous factors affect the potency of the male in different ways. These exogenous factors include modern lifestyle such as wearing tight cloth, prolong driving, seating job, etc., poor or contaminated diet, deteriorating environment, aging, obesity, radiation exposures, and consumption of alcohol, tobacco and drugs. Further, occupational exposures to number of noxious agents in metallic, chemical and gas industries, or exposure to pesticides add on risks to male fertility. This article glimpses on some exogenous factors and their correlation with the prevailing male infertility cases.

Keywords: Male infertility, environmental/physical/chemical factors, lifestyle, occupational exposure

INTRODUCTION
During the assessment of an infertile male, a clinician thinks about an excellent selection of factors those have an effect on his reproductive potential. Thus, it is apparent that the contributions of medications, persistent diseases, and life-style should be examined carefully. Infertility is defined as the failure to conceive and is a frequent disease that can affect up to 15% of couples [1]. Interestingly, 50% of these instances are generally attributed to male factor. However, there are some cases of idiopathic infertility, which don’t have any defined etiology and factor(s) behind the infertility are mostly unknown [2]. Infertility is a serious global health issue now. Male semen quality including sperm count and sperm motility has declined over a period of time. Since last four decades or so, there is a decrease of about 40-60% total sperm count in America, Australia and Europe [3]. Worldwide >186 million people face infertility problem, the majority being residents of developing nations [4].

Semen analysis is very much important and it is a basic method to evaluate the male potential [5][6][7]. Male infertility is also varied by place-to-place and season-to-season. So, it is very important to design the
population and geographic base study to discern male infertility accurately. Numerous published literature describe that male infertility is linked with numerous factors; however, their validation seems controversial. Modern lifestyle, exposure to dwindling environment, radiation, health complications like obesity and aging, job related work pressure, etc. are the factors behind male infertility. However, our society is unaware of these factors associated with male infertility. The environment is abundant around us and therein carries many noxious substances that negatively affect male reproductive potential too. As per WHO, a quarter of diseases in the world arise because of contaminated environment [8]. In addition, behavioral factors such as consummation of tobacco, alcohol and drugs influence the male infertility. It has been observed that the number of smokers and drunkards is increasing day by day, especially the age group of 29-30 years., in which about 46% young population is smokers [9]. Among the etiological factors concerned with male infertility, drug-related illnesses should be investigated [10]. Diet pattern is continually changing, people prefer fast food more as compare to proper diet. The food rich in calories, trans fatty acid, cholesterol, caffeine is having negative correlation with sperm quality. Food pattern is one of the important reasons behind male infertility [11][12].

This manuscript is focused on various exogenous factors those are reported to be influence the male infertility.

EXOGENOUS FACTORS

1. Lifestyle

The lifestyle of humans is always on changing mode. Modern lifestyle causes various detrimental effects on human reproductive health.

A) Physical activity: Physical work is declining day to day in life. Numerous factors like seating jobs [13], work from home, easily availability of vehicles, these are the some of the reasons behind the decline in physical exercise. According to Hayden et. al. physical activity, diet, exercise is required for maintaining the body energy level. Less physical activity is responsible for male infertility [14]. It has been suggested that moderate exercise or Yoga everyday may reduce male infertility [15][16].

B) Alcohol consumption: One of the leading modern-day lifestyles is the consumption of alcohol. It has been reported that alcohol consumption leads to various health problems. Infertility is one of the important physiological disorders caused by alcohol consumption. Infertility and its association with alcohol consumption were first reported in the year of 1985 [17]. It has been reported that 30% of women and 42% of men are binge drinkers with having sexual transmitted diseases (STDs) [18]. Alcohol consumptions lead to changing sexual behavior [19]. It has been also reported that the intake of alcohol >25 units per week reduces the semen quality. Most of the infertile couples have an asthenozoospermic male partner. Asthenozoospermia is the initial sign of a reduction in the quality of spermatozoa. Alcohol consumption also
leads to a defect in sperm morphology and spermatogenesis [20][21]. Chronic consumption, as well as acute consumption of alcohol leads to reduced viability and enhances the apoptosis of germ cells by overexpression of caspase-3 mRNA in Sertoli cells [22][23]. Chronic exposure of alcohol is responsible for the expression of FAS ligand in the testes and also responsible for the demethylation of hypermethylated regions of sperm DNA that may result in DNA fragmentation [24]. Further, acute or occasional alcohol consumption does not lead to infertility but the accumulation of macrocephalic sperm may damage the DNA [25][26].

C) Smoking

Reports show that there is a massive perilous effects of tobacco smoking on fertility and reproduction. Studies have shown that tobacco consumption affects the reproductive system [27], [28]. Sperm motility has been found to decrease by smoking [23]. To date, over 4700 chemicals have been found in tobacco, which includes heavy metals, polycyclic aromatic hydrocarbons (PAHs) and mutagenic chemicals [29]. Among these heavy metals such as Lead, Arsenic and Cadmium are commonly exposed to the human body by tobacco smoking, which are generally brings in oxidative stress and male infertility in humans [30]. Apart from this, consumptions of cannabinoids such as marijuana may adversely affect male fertility [31]. Bad habits not only affect the natural fertilization but also shows less success in ARTs (Assisted Reproductive Technologies) like IVF (in vitro-fertilization) [32].

D) Diet

Due to changes in lifestyle, diet patterns of humans have also got changed over a period of time. Diet is one of the important factors closely connected with male infertility. In agriculture, the uses of pesticide, herbicide, and fungicide have increased day-by-day to get more yields. As a result of overdosing, some amount of chemicals remains in the food and some chemicals leak out to the environment. Human testicles of male reproductive system are too much susceptible to such environmental, physical and chemicals agents [33]. Salas-Huetos et. al. have emphasized on the healthful diets rich in essential nutrients such as omega-3 fatty acids, antioxidants (Vit. E, C & D, folate, β-carotene, selenium, zinc, cryptoxanthin, lycopene, etc), and diets low in saturated fatty acids and trans-fatty acids have positive impact on semen parameters. It has also been reported that seafood, poultry, cereals, green vegetables and fruits, low fat dairy milk are positively related with numerous sperm/semen parameters. Now-a-days fast food such as processed meat, soy foods, potatoes, full-fat dairy and whole dairy products, cheese, coffee, alcohol, sugar-sweetened drinks and sweets consumption is trending in new generation, which lacks essential nutrients. Fast food is having negative impact on semen parameter [11]. The healthy diet must contain all the essential nutrients, which makes males more potential. Deficiency of vitamins, specially Vit.-D and Vit.-E have been found to reduce the male fertility potential [34]. Oryzylowska et. al. have reported that that a lifetime
vegetarian diet shows the low quality of semen because vegans are compromised in calcium which is required for hyperactivation of sperms [35]. According to Jensen et. al. addiction to caffeine affects the semen quality [36]. Moderate intake of caffeine has not yet shown much effect, however, heavy doses of caffeine affect the normal morphology, sperm count, BMI and disturbance in hormonal balance [36][37].

2. Pesticides and insecticides

There are various reports on the adverse effects of pesticides and insecticides on male infertility. Exposure to these agents has been observed to negatively affect spermatogenesis by disrupting gonadal pituitary axis, testicular cell functions, etc. [38][39]–[41]. According to Manikkam et. al. mosquito repellent is a mixture of two chemical Permethrin and DEET. They exposed the female rats (F0 generation) to this mixture of insecticides and found significant increase in the incidence of male infertility with reduction in the volume of testes, sperm count and pubertal abnormalities of succeeding generations (F1 and F3) those were not exposed to these chemicals [42].

3. Endocrine disturbing chemicals (EDC)

Studies have shown that the use of endocrine disturbing chemicals (EDCs) adversely affect the male fertility potential [43][44]. EDCs such as BPA (bisphenol-A) used for various purposes such as for interior covering of food, the cans of beverages, soap, lotion, nail polishes, shampoos, thermal receipt papers, etc. There are millions of tons of BPA produced in worldwide and hundreds of tones are released into the atmosphere. Entry points of BPA in human beings are ingestion, inhalation, and dermal absorption. BPA is structurally similar to estrogen and interferes with the endocrine system of humans [45]. Growing children are having more risk with EDC as they play with the toys/exhibits/goods made up of such chemicals. This is important that the nation must make some legislation to avoid the use of such goods. French parliament in 2015 avoided the use of EDCs like BPA and phthalate DEHP in their goods related to children toys. In the USA also the legislation has been made to control the use of EDC containing goods [43], [44].

4. Radiation

According to some researchers changing lifestyles like the use of mobiles and Wi-Fi radiations increase the risk of infertility in men. Its effects have been seen on spermatogenesis, motility of the sperm, sperm count and DNA integrity. Further, a study by Delavarifar et.al. have shown that radiation from internet WI-FI can induce infertility in mice [46].

5. Aging

Harris et. al. have reported that male infertility increases with age factor [47], [48]. Erectile Dysfunction (ED) also increases with the age. Semen parameters like motility, morphology, sperm concentration and
volume get reduced, as age increases. It has been found that that male sperm motility is decreases by 0.17%-0.6% per year of age. Similarly, morphology also reduces to 0.2-0.9% per year of age. Volume also moderately reduce 0.15-0.2% per year of age (34). Aging is a natural process in all living cells. Late pregnancies in women are associated with numerous reasons like economy, high standards of living and career planning. However, it is not much clear yet exactly how paternal age affects the probability of pregnancy [49]. The advanced paternal age of males affects their reproductive system in many ways. Negative impacts of age have been seen on testicular size and its metabolism process. When age increases from puberty to 30-40 years of age testicular size and metabolism increase continually [50]. Between 40-60 years of age the volume of testes and metabolism remain constant, however, after the age of 60 years testicular volume and metabolism start to decrease, and at the age of 90 years the volume of testes and its metabolisms significantly decreases [51][52].

6. Obesity

Obesity is a worldwide issue. According to standards of BMI, 312 million peoples are obese and >1.1 billion people are overweight globally [53]. Obesity affects sperm motility, which is an important parameter of male infertility. If motility is >40%, the male semen impression is considered as asthenozoospermic, which shares 80% of the total cause of male infertility [54]. Obesity has an impact on each and every aspect of the semen parameter. Obesity is also associated with hormonal imbalance, which slow down the spermatogenesis and reduces the semen quality as well as responsible for ED. Increase in body weight has been reported to be associated with reduced testosterone levels in blood [53]. In obese person the gonadotropin level gets slightly reduced due to low secretions of hypothalamic gonadotropins releasing hormones (GnRH) [52]. Further, Pasquali et. al. have found that the estrogen production is directly proportional to body weight. As body weight increases the estrogen level also increases, this induces negative feedback mechanism of testosterone, which reduces testosterone level. Due to this negative feedback mechanism estrogen is unable to regulate the secretion of the gonadotropins [53]. Bose et. al. have reported that hyperactivity of the hypothalamus-pituitary-axis in obese persons reduces the testosterone level [55].

7. Environmental Factors

Understanding the environmental factors and their correlation with male infertility is very challenging. India is a country with different seasons, different weather, and different cultures. Human body also has different morphology and physiology. At each moment effects of different factors, and exposure time modulates human body in different way, therefore basic and in-depth study is required to decipher the underlying knowhow of these relationships. According to Ahmet Ayaz et.al reproductive health is reflected by environment factors. Environmental factors affect the spermatozoa in many ways like, sperm morphology, spermatogenesis, and DNA integrity of the sperm [56]. Mainly environmental factors affect the Sertoli cells,
germ cells, Leydig cells, prostate glands and seminal vesicle, which results in defective spermatozoa that lead to male infertility [57].

CONCLUSION

Several reports describe that male infertility is multifactorial. Numerous exogenous factors affect the male potential. Adopting a healthy lifestyle may reduce the male infertility issue. Diets that include the essential nutrients can help to maintain reproductive health. Bad habits like alcohol, tobacco and drugs consumption should be avoided or limited. Physical exercise and stress-free life is also beneficial to overcome the male infertility. However, more studies are required to focus on specific factor(s) and analyze their impact on male potential.

REFERENCES


and Endocrinology. 2015.


