



An Overview of Male and Female Infertility: Etiology, Risk Factors, and Treatment Approaches

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Abstract

Infertility is a global health issue characterized by the inability to conceive after one year of regular, unprotected intercourse. It affects both men and women and has significant psychological, social, and economic implications. Infertility affects approximately 15% of couples worldwide. The prevalence varies by region, with higher rates observed in certain parts of Africa and South Asia. The global burden of infertility is significant, impacting millions of individuals and couples each year. Both male and female factors contribute to infertility, with male factors accounting for about 30%, female factors for about 40%, and combined or unexplained factors making up the remaining 30%. The etiology of infertility is diverse, encompassing a wide range of biological, genetic, environmental, and lifestyle factors. Common causes include ovulatory disorders, tubal blockage, endometriosis, and uterine abnormalities in women, and low sperm count, poor sperm motility, and abnormal sperm morphology in men. Additionally, age, obesity, and exposure to environmental toxins can significantly impact fertility. Treatment options for infertility are varied and depend on the underlying cause. They range from lifestyle modifications and pharmacological treatments to assisted reproductive technologies (ART) such as *in vitro* fertilization (IVF) and intracytoplasmic sperm injection (ICSI). Hormonal therapies, surgical interventions, and use of donor gametes are other options. Recent advances in reproductive medicine, including genetic screening and fertility preservation techniques, offer hope for many couples facing infertility challenges. In conclusion, Infertility is a complex condition with multiple contributing factors. Comprehensive evaluation and personalized treatment strategies are essential for effective management. Continued research and advancements in reproductive medicine are crucial to improve outcomes for individuals and couples experiencing infertility.

Keywords: Infertility; Reproductive Disorders; Assisted Reproductive Technologies; *In-Vitro* Fertilization; Intracytoplasmic Sperm Injection; Lifestyle Modifications

Abbreviations

ART: Assisted Reproductive Technologies; IVF: *In-Vitro* Fertilization; ICSI: Intracytoplasmic Sperm Injection; TESE: Testicular Sperm Extraction; IUI: Intrauterine Insemination; PCOS: Polycystic Ovary Syndrome; PID: Pelvic Inflammatory Disease; STIs: Sexually Transmitted Infections; PESA: Percutaneous Epididymal Sperm Aspiration; PGT: Preimplantation Genetic Testing

Introduction

According to the World Health Organization (WHO), infertility is a disease of the reproductive system defined by the failure to achieve a clinical pregnancy after 12 months or more of regular, unprotected sexual intercourse [1]. This condition can affect both men and women, with various factors contributing to its occurrence. For women, infertility may result from issues such as ovulatory disorders, uterine abnormalities, or fallopian tube damage [2]. In men, it can stem from factors like low sperm count, poor sperm motility, or hormonal imbalances [3]. Infertility is a significant public health concern, affecting millions of individuals globally and leading to considerable emotional, psychological, and social challenges [4]. The WHO emphasizes the importance of accessible and effective infertility treatments, including assisted reproductive technologies, to help couples achieve their desired family size [5].

Epidemiology

Worldwide

Infertility is a global health issue affecting millions of couples. According to the World Health Organization [WHO], approximately 48 million couples and 186 million individuals live with infertility globally [6]. The prevalence of infertility varies by region and is influenced by several factors, including socioeconomic conditions, cultural practices, and access to healthcare [7]. The global infertility rate is estimated at 10-15% among couples of reproductive age. This rate encompasses both primary infertility (the inability

to conceive at all) and secondary infertility (the inability to conceive after previously giving birth) [8]. Infertility rates are generally higher in low- and middle-income countries, often due to untreated infections, lack of medical care, and sociocultural factors [9]. For example, in sub-Saharan Africa, the prevalence of secondary infertility is particularly high. Both men and women are affected by infertility, though the underlying causes differ [10]. Male infertility factors account for about 20-30% of cases, while female factors account for 20-35%, and combined male and female factors account for 25-40% [11].

In India

Infertility is also a significant concern in India, with various studies highlighting its prevalence and impact on couples' lives. In India, the prevalence of infertility is estimated to be around 10-15% among married couples. This figure translates to millions of couples experiencing infertility issues [12]. Infertility rates tend to be higher in urban areas compared to rural areas, potentially due to lifestyle factors such as stress, delayed marriages, and increased age at first pregnancy [13]. However, rural areas also face challenges related to healthcare access and untreated reproductive tract infections [14]. Similar to global trends, both male and female infertility factors contribute to the overall prevalence in India. Cultural and social pressures often place a greater burden on women, leading to significant emotional and psychological distress [15].

Etiology

Infertility, defined as the inability to conceive after 12 months of regular, unprotected intercourse, can be attributed to a variety of factors affecting both men and women [16]. Understanding the etiology of infertility is crucial for diagnosis and treatment. Here are the primary causes of infertility for both genders.

Female factors

Factors	Remarks
Ovulatory Disorders	
Polycystic Ovary Syndrome (PCOS)	A hormonal disorder causing irregular ovulation or anovulation.
Hypothalamic Dysfunction	Disruption in the hormones produced by the hypothalamus affecting ovulation.
Premature Ovarian Insufficiency	Early depletion of ovarian follicles leading to menopause before age 40.
Hyperprolactinemia	Elevated levels of prolactin inhibiting ovulation [17]

Tubal Factors	
Fallopian Tube Damage or Blockage	Often caused by pelvic inflammatory disease (PID), endometriosis, or previous surgeries, preventing the egg and sperm from meeting. Tubal Ligation: Surgical sterilization that blocks or cuts the fallopian tubes.
Tubal Ligation	Surgical sterilization that blocks or cuts the fallopian tubes [18]
Uterine and Cervical Factors	
Uterine Fibroids	Noncancerous growths in the uterus that can interfere with implantation.
Endometrial Polyps	Growths in the lining of the uterus that may affect implantation.
Congenital Uterine Abnormalities	Structural abnormalities present from birth.
Cervical Stenosis	Narrowing of the cervix, affecting sperm passage.
Inadequate Cervical Mucus	Mucus that is not conducive to sperm mobility or survival [19]
Endometriosis and Age-Related Factors	
Endometriosis	A condition where endometrial tissue grows outside the uterus, causing inflammation, scarring, and often pain, potentially impacting fertility.
Age-Related Factors	Decline in the number and quality of eggs with advancing age, particularly noticeable after age 35 [20]

Table 1

Male factors

Factors	Remarks
Sperm Production and Function Disorders	
Oligospermia	Low sperm count.
Azoospermia	Absence of sperm in ejaculate.
Asthenozoospermia	Poor sperm motility.
Teratozoospermia	Abnormal sperm shape [21]
Genetic Disorders	Conditions like Klinefelter syndrome affecting sperm production.
Hormonal Imbalances	Disorders affecting the hypothalamus, pituitary gland, or testicles, leading to inadequate hormone levels required for sperm production.
Varicocele	Enlargement of veins within the scrotum, potentially affecting sperm quality.
Obstructions	Blockages in the ducts carrying sperm from the testicles to the penis, often due to infections, surgeries, or congenital defects.
Sexual Dysfunction	Issues such as erectile dysfunction or premature ejaculation can prevent successful intercourse [22].

Table 2

Lifestyle and environmental factors

Factors	Remarks
Lifestyle Factors	
Obesity	Associated with hormonal imbalances and ovulatory disorders.
Smoking	Affects both male and female fertility.
Alcohol and Drug Use	Can impair reproductive function.
Stress	Can impact hormonal balance and sexual function [23]
Environmental Factors	
Exposure to Toxins	Pesticides, heavy metals, and other environmental toxins can impair fertility.
Radiation and Chemotherapy	Treatments for cancer can severely affect reproductive organs [24]

Table 3

Rationale for the study

Infertility is a critical public health issue that affects millions of individuals and couples worldwide [25]. Despite advances in medical science and assisted reproductive technologies (ART),

infertility remains a complex and multifaceted condition with significant emotional, psychological, and social implications [26]. The need for a comprehensive review of current knowledge, research, and treatment options is crucial for several reasons. The Prevalence and impact of infertility with an estimated 10-15% of couples globally experiencing infertility, the condition poses a substantial burden on public health systems [27]. In India, similar prevalence rates highlight the widespread nature of this issue [28]. Understanding the epidemiology, etiology, and psychosocial impact of infertility is essential for developing effective public health strategies and interventions.

The rationale for writing this review article on infertility is driven by the need to consolidate and disseminate current

knowledge, address gaps in understanding, and propose evidence-based solutions to improve the management and outcomes of infertility. This comprehensive approach is vital for advancing public health, enhancing patient care, and fostering an informed and equitable healthcare system.

Risk factors for infertility

Infertility can be influenced by a range of risk factors affecting both males and females. These factors can be biological, environmental, lifestyle-related, or a combination of these [29]. Understanding these risk factors is crucial for prevention, early diagnosis, and effective management.

Risk factors for female infertility

Risk Factors	Remarks
Age	
Decreased Ovarian Reserve	The quantity and quality of a woman’s eggs decline with age, especially after age 35.
Increased Risk of Chromosomal Abnormalities	Older eggs are more likely to have chromosomal issues, increasing the risk of infertility and miscarriage [30]
Hormonal Disorders	
Polycystic Ovary Syndrome (PCOS)	A common endocrine disorder causing irregular ovulation.
Thyroid Disorders	Both hyperthyroidism and hypothyroidism can disrupt menstrual cycles and ovulation.
Hyperprolactinemia	Elevated prolactin levels can inhibit ovulation [31].
Lifestyle Factors	
Obesity	Associated with hormonal imbalances and increased risk of ovulatory dysfunction.
Underweight	Insufficient body fat can lead to irregular menstrual cycles and anovulation.
Smoking	Harms the ovaries, reducing the quality and number of eggs.
Alcohol Consumption	Excessive drinking can affect hormone levels and ovulation.
Caffeine	High caffeine intake has been linked to decreased fertility in some studies [32].
Medical Conditions	
Endometriosis	Growth of endometrial tissue outside the uterus can cause inflammation and scarring.
Pelvic Inflammatory Disease (PID)	Infections that cause inflammation and scarring of the fallopian tubes.
Uterine or Cervical Abnormalities	Structural issues like fibroids, polyps, or congenital abnormalities.
Autoimmune Disorders	Conditions like lupus can interfere with fertility [33].
Environmental Factors	
Exposure to Toxins	Pesticides, heavy metals, and industrial chemicals can affect reproductive health.
Radiation and Chemotherapy	Treatments for cancer can harm reproductive organs and affect fertility [34].
Psychological Factors	
Stress	High levels of stress can affect hormone levels and menstrual cycles [35].

Table 4

Risk factors for male infertility

Risk Factors	Remarks
Lifestyle Factors	
Smoking	Reduces sperm quality, motility, and count.
Alcohol Consumption	Excessive drinking can lead to reduced testosterone levels and impaired sperm production.
Drug Use	Anabolic steroids, marijuana, and other drugs can negatively impact sperm production and function.
Obesity	Linked to hormonal imbalances that can reduce sperm quality and quantity [36]
Medical Conditions	
Varicocele	Enlarged veins within the scrotum can affect sperm quality.
Infections	Sexually transmitted infections (STIs) and other infections can cause inflammation and blockages in the male reproductive tract.
Hormonal Disorders	Conditions affecting the hypothalamus, pituitary gland, or testicles can impair sperm production.
Genetic Disorders	Conditions like Klinefelter syndrome can affect sperm production and quality.
Previous Surgeries	Surgeries involving the testicles, prostate, or other reproductive organs can impact fertility.
Chronic Illnesses	Diabetes, hypertension, and other chronic conditions can impair sperm production and function [37].
Environmental Factors	
Exposure to Heat	Prolonged exposure to high temperatures, such as from hot tubs or tight clothing, can reduce sperm production.
Occupational Hazards	Exposure to chemicals, radiation, and heavy metals in certain jobs can affect fertility.
Radiation and Chemotherapy	Cancer treatments can severely impact sperm production and quality [38]
Age	
Decreased Sperm Quality	Sperm quality and motility decline with age, although men remain fertile longer than women [39].
Psychological Factors	
Stress	High stress levels can impact hormone levels and sperm production [40].

Table 5

Treatment methods for infertility

Infertility treatment depends on various factors, including the underlying cause, the age of the individuals, how long they have been infertile, and their personal preferences. Below are detailed treatment methods for both male and female infertility.

Treatment methods for female infertility

Lifestyle and behavioural changes

- **Weight Management-** Achieving a healthy weight can improve ovulation and increase the chances of conception [41].

- **Diet and Nutrition-** A balanced diet rich in vitamins and minerals supports reproductive health [42].
- **Stress Reduction-** Techniques like yoga, meditation, and counseling can reduce stress and improve overall well-being [43].

Medical treatments

- **Ovulation Induction-** Medications such as clomiphene citrate, letrozole, and gonadotropins stimulate ovulation [44].

- Metformin- Used to treat insulin resistance often associated with polycystic ovary syndrome (PCOS) to help restore normal ovulation [45].
- Hormone Therapy- Treatments for thyroid disorders, hyperprolactinemia, or other hormonal imbalances [46].

Surgical treatments

- Laparoscopy- Minimally invasive surgery to remove endometriosis, ovarian cysts, or scar tissue.
- Hysteroscopy- Procedure to remove uterine fibroids, polyps, or correct uterine abnormalities.
- Tubal Surgery- Procedures to repair blocked or damaged fallopian tubes [47].

Assisted reproductive technologies (ART)

- *In Vitro* Fertilization (IVF)- Eggs are fertilized with sperm in a laboratory, and the resulting embryos are implanted in the uterus.
- Intracytoplasmic Sperm Injection (ICSI)- A single sperm is injected directly into an egg during IVF.
- Egg Donation- Eggs from a donor are fertilized and implanted in the recipient's uterus.
- Embryo Donation- Donated embryos are implanted in the uterus.
- Surrogacy- A surrogate carries the pregnancy for individuals or couples unable to conceive [48].

Other treatments

- **Intrauterine Insemination (IUI):** Sperm is directly placed into the uterus around the time of ovulation [49].
- **Fertility Preservation:** Egg or embryo freezing for individuals undergoing treatments that may affect fertility, like chemotherapy [50].

Treatment methods for male infertility

Lifestyle and behavioural changes

- Diet and Nutrition- A diet rich in antioxidants, vitamins, and minerals can improve sperm quality.
- Weight Management- Achieving a healthy weight can improve hormone levels and sperm production.

- Avoiding Toxins- Reducing exposure to tobacco, alcohol, and environmental toxins.
- Heat Avoidance- Avoiding prolonged exposure to high temperatures from hot tubs or tight clothing.
- Antioxidant Supplements- Vitamins C and E, selenium, and CoQ10 may improve sperm quality [51].

Medical treatments

- Hormone Therapy- Treatment for hormonal imbalances, such as gonadotropin therapy for low testosterone. If infertility is due to hormonal imbalances, medications like Clomiphene Citrate, hCG, or FSH can stimulate sperm production.
- Medications- Antibiotics for infections, medications for erectile dysfunction or ejaculatory disorders [52].

Surgical Treatments

- **Varicocele Repair-** Surgery to remove enlarged veins within the scrotum.
- **Vasectomy Reversal-** Reconnecting the vas deferens to allow sperm to be present in the ejaculate.
- **Sperm Retrieval Techniques-** Procedures such as testicular sperm extraction (TESE) or percutaneous epididymal sperm aspiration (PESA) to obtain sperm directly from the testicles or epididymis [53].

Genetic treatments

- Genetic Counseling- For couples with genetic disorders that may affect fertility or offspring health [54].
- Preimplantation Genetic Testing (PGT)- Testing embryos for genetic abnormalities before implantation during IVF [55].

Overall, Infertility treatments are varied and tailored to the individual's or couple's specific needs. Working with fertility specialists can help identify the best treatment options to increase the chances of a successful pregnancy. Infertility affects many couples globally, necessitating a diverse range of treatment options for both male and female infertility.

For females, treatment methods include medications such as Clomiphene Citrate and Gonadotropins to stimulate ovulation, surgical interventions like laparoscopic and hysteroscopic surgeries to correct anatomical abnormalities, and advanced assisted

reproductive technologies (ART) such as Intrauterine Insemination (IUI), *In Vitro* Fertilization (IVF), and Intracytoplasmic Sperm Injection (ICSI). Complementary therapies, lifestyle modifications, and psychological support play significant roles in enhancing treatment outcomes.

Male infertility treatments focus on hormonal therapies, antibiotics for infections, surgical corrections like varicocele repair and vasectomy reversals, and sperm retrieval techniques. ART procedures, including IUI, IVF, and ICSI, are also pivotal for addressing severe male infertility. Lifestyle changes, antioxidant supplements, and psychological support are integral in improving sperm quality and overall reproductive health. This comprehensive approach to infertility treatment underscores the importance of individualized care plans developed in collaboration with fertility specialists to optimize the chances of achieving successful pregnancies.

Conclusion

Infertility affects millions globally and in India. While prevalence is similar worldwide, regional variations, healthcare access, and sociocultural factors influence its landscape. Improving healthcare infrastructure, increasing awareness, and reducing stigma are crucial to addressing this public health challenge. Infertility is multifactorial, with diverse causes. Understanding these factors is essential for effective diagnosis, management, and treatment, providing hope and solutions for those affected.

Identifying risk factors for infertility in both males and females is crucial for early detection, prevention, and treatment. Addressing lifestyle choices, managing medical conditions, and reducing exposure to environmental toxins can significantly improve reproductive health and outcomes. Infertility treatment is highly individualized, depending on the underlying causes in each partner. Options range from lifestyle modifications and medical treatments to advanced surgical procedures and ART. Collaboration between patients and healthcare providers is essential to determine the most effective treatment plan. Continued research and advancements in reproductive medicine are crucial to improve outcomes for individuals and couples experiencing infertility.

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Conflict of Interest

The authors state that they have no conflicts of interest.

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