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Research Paper

Epidemiological Perspectives on Female Infertility in India: Risk Factors, Trends, and Regional Variations

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ABSTRACT

In India, female infertility constitutes a major public health problem, affecting millions of women who reside within diverse socio-economic, socio-cultural, and geographical environments. The current study reviews data available in the literature regarding epidemiology of female infertility in India, including prevalence, aetiology, incidence trends, and geographic variations. Rates of primary infertility range from 3.9% to 16.8%, depending upon the region in question, with secondary infertility making up a significant proportion of all infertile cases. Some of the main determinants of infertility among Indian females include polycystic ovary syndrome (PCOS), reproductive tract infection, tuberculosis, undernourishment, early marriages, delayed first pregnancy, and more recently developed causes, such as obesity. There is an observable variation in prevalence rate with respect to different geographic regions, being high among eastern and northeastern states of India due to their poverty levels, less medical care accessibility, and a higher burden of infectious diseases. Urban areas have been increasingly reporting cases of infertility related to delayed pregnancies and lifestyle issues, while those residing in rural areas are mainly affected by infectious causes and undernourishment. This review highlights the urgent need for region-specific, integrated public health interventions, improved surveillance systems, and equitable, culturally sensitive reproductive healthcare services to address the complex and evolving burden of female infertility in India.

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INTRODUCTION

Infertility is defined by the World Health Organization (WHO) as the inability to achieve a clinical pregnancy after 12 months or more of regular, unprotected intercourse between couples (WHO, 2023). In India, a country with a population exceeding 1.4 billion, which also demonstrates extreme diversity in demographics and culture, the prevalence of female infertility poses a complicated epidemiological situation. Despite being a condition that involves both parties equally, the contribution of female factors is estimated at 40–55% among all infertile couples in South Asia, thus requiring further attention as an object of public health research (Gurunath et al., 2011). Besides its biomedical implications, infertility affects Indian women socially. Due to the importance of motherhood in the traditional culture, women who are unable to conceive often face social stigma, family problems, depression, and isolation (Riessman, 2000; Dyer et al., 2004). Infertility in low- and middle-income countries such as India carries a far higher social cost than its clinical scale indicates, so holistic epidemiological research is an urgent need. While infertility has gradually been recognized as a public health issue globally, India still lacks a nationally standardized infertility surveillance system. Existing studies have produced drastically divergent prevalence estimates due to differences in research methods and other relevant factors. This review sorts out the epidemiological characteristics of female infertility in India, covering prevalence, etiologies and risk factors, 20-year temporal trends, and regional differences across the country's states and union territories. It provides support for identifying high-risk groups, clarifying causal relationships, and guiding policy development.

Prevalence and Magnitude of Female Infertility in India

Measuring the true prevalence of female infertility in India faces significant methodological challenges. The National Family Health Survey (NFHS), India's core source of national reproductive health statistics, cannot directly calculate infertility rates, and can only produce indirect estimates using childlessness rates and birth intervals. In 1999, Unisa adopted a demographic approach to estimate that around 13 to 14 million couples in India lived with infertility by the end of the 1990s, a total that has grown substantially in the decades since. Studies by Gurunath et al. (2011) and Nachtigall (2006) find that the prevalence of primary infertility (defined as never having achieved a successful pregnancy) among women of reproductive age ranges from 3.9% to 6.8%. Research by Kumar & Singh (2015) notes that the prevalence of secondary infertility (defined as having a prior history of pregnancy) reaches 8% to 16.8%, with this burden being particularly acute among rural and tribal populations. Data from NFHS-5 (2019-2021), released by India's Ministry of Health and Family Welfare in 2021, shows that 4.5% of married women aged 15 to 49 who had been married for at least five years had no live births, providing an indirect indicator of India's infertility burden that carries policy-relevant value for decision-making. India is one of the countries in the Asia-Pacific region with a relatively heavy infertility burden, but significant heterogeneity exists in this burden across states, urban and rural areas, and social strata. Disaggregated analysis is required to support targeted, precision interventions.

Risk Factors for Female Infertility in India

Polycystic Ovary Syndrome (PCOS)

Polycystic ovary syndrome is one of the most common endocrine conditions affecting women in their reproductive years in India and an anovulatory form of infertility. Prevalence rates in Indian women diagnosed with PCOS vary between 9.13 and 22.5%, based on diagnostic criteria used (Bhattacharya & Jha, 2010; Nidhi et al., 2011). The Rotterdam criteria include oligo/anovulation, clinical/biochemical evidence of hyperandrogenism, and polycystic ovarian syndrome and require any two of the three features to be present for a diagnosis. According to Kauffman et al. (2019), urban Indian women, especially those who lead a sedentary lifestyle and consume high calorie foods, are at higher risk of developing this condition.

Reproductive Tract Infections and Sexually Transmitted Infections

Reproductive tract infections (RTIs) and sexually transmitted diseases (STDs) remain a major yet often unrecognised cause of infertility in females in India, especially tubal factor infertility due to ascending infections and pelvic inflammatory disease (PID). Among the different microorganisms involved, Chlamydia trachomatis and Neisseria gonorrhoeae emerge as the most epidemiologically important agents, since subclinical infection is fairly common and often leads to late diagnosis and therapy (Sharma et al., 2009). The prevalence of Chlamydia positivity has been reported in studies carried out in several states across India at rates ranging between 20 and 40% in infertile patients visiting tertiary healthcare facilities, substantially higher when compared with fertile controls (Joyee et al., 2005).

In spite of not being considered an STD in itself, bacterial vaginosis is related to upper genitourinary tract inflammation and poor reproductive outcomes. Poor menstrual hygiene practices, lack of access to safe drinking water and proper sanitation, as well as inadequate sexual education also contribute to the high prevalence of RTIs in the country.

Genital Tuberculosis

The Indian subcontinent constitutes about 26% of the world's TB cases, while FGTB stands out as a peculiar yet significant contributor to infertility problems, which carries special significance only within the South Asian geographical area (World Health Organization, 2023). FGTB refers to the hematogenous dissemination of Mycobacterium tuberculosis to the fallopian tubes, endometrium, and ovaries, causing damage in the form of scarring and tubal occlusions. According to the current studies, FGTB is estimated to constitute between 5% and 10% of all causes of infertility in India, with the rates of the disease being especially high among patients living in the states

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where TB is prevalent, namely Uttar Pradesh, Rajasthan, Bihar, and Jharkhand (Sharma et al., 2018).

Nutritional Factors and Anaemia

Nutritional factors play an important role in reproductive health in females. Malnutrition, specifically chronic energy malnutrition and micronutrient deficiencies, including iron, folic acid, vitamin D, and zinc affect the hypothalamus-pituitary-ovarian hormonal interaction, leading to the disruption of follicular development and ovulation (Ghosh & Shah, 2004). India holds one of the highest rates of anemia amongst females globally. According to NFHS-5 data, 57% of non-pregnant females in the age group 15-49 suffer from anemia (MoHFW, 2021). Anemia, specifically severe anemia, has been linked with irregular menstruation, anovulation, and endometrial implantation defects, further increasing the chances of infertility. On the contrary, obesity, a common problem amongst urban Indian women, increases the risk of PCOS and anovulation and lowers the chances of assisted reproduction technology success (Maheshwari et al., 2007).

Age at Marriage and Childbearing

The relatively high incidence of early marriage in India, although on the decline in recent years, had been previously noted for its paradoxical role in causing both increased fertility and increased risk of infertility. Early sexual activity is linked with increased susceptibility to RTIs, while multiple pregnancies and mishandled delivery due to early marriage led to an increased likelihood of post-delivery infections as well as secondary infertility (Ram & Singh, 2006). In contrast, urbanization and education play a role in delaying pregnancy amongst educated urban females who choose not to bear children, thereby increasing their likelihood of reduced ovarian reserve due to age (Maheshwari et al., 2008).

Environmental and Occupational Exposures

Environmental and occupational toxins have recently been identified as possible risk factors for female infertility in India. Exposure to pesticides among agricultural workers, who account for a significant percentage of India's rural female workforce, is known to result in hormonal imbalance, poor follicular maturation, and menstrual problems (Bretveld et al., 2006). Other toxicants from industries, including heavy metals like lead, mercury, and cadmium, and endocrine-disrupting chemicals like bisphenol-A and phthalates in plastic packaging materials, are emerging as reproductive toxins. The recent industrialization and lack of environmental regulations in several Indian states are worsening the problem, although research in this area among Indian populations is still in its infancy (Mishra et al., 2019).

Regional Variations in Female Infertility in India

Regional disparities in female infertility reflect the intersection of ecological, socioeconomic, and healthcare-access factors. The following table summarises key epidemiological characteristics across Indian regions.

Table 1: Regional Variations in Female Infertility Prevalence and Risk Factors Across India

Region / State	Infertility Prevalence (%)	Primary Risk Factors	Rural Urban Disparity
Northern India (UP, Bihar, Rajasthan)	3.9 – 6.8	PCOS, early marriage, malnutrition	High (limited access)
Southern India (Tamil Nadu, Kerala)	3.5 – 5.2	Endometriosis, STIs, delayed childbearing	Moderate (better services)
Eastern India (WB, Odisha, Jharkhand)	5.0 – 7.4	Tuberculosis, anaemia, poor sanitation	Very High
Western India (Maharashtra, Gujarat)	4.1 – 6.0	Lifestyle factors, PCOS, obesity	Moderate
Northeastern India	4.5 – 6.5	STIs, limited healthcare, tribal practices	Very High
National Average	~3.9 – 16.8*	Multifactorial	Significant

Note. *Range reflects variation across multiple studies using different diagnostic criteria. STI = sexually transmitted infection; PCOS = polycystic ovary syndrome; WB = West Bengal; UP = Uttar Pradesh.

States in northern India such as Uttar Pradesh, Bihar, and Rajasthan face relatively higher infertility rates due to a combination of factors including higher rates of early marriage, malnutrition, lack of education for women, and insufficient facilities for reproductive health services. Secondary infertility due to post-partum infection and genitourinary TB is more prevalent in these states (Kumar & Singh, 2015). States located in eastern India, namely West Bengal, Odisha, and Jharkhand, have among the highest rates in the country, owing to TB endemicity, high levels of anaemia, and wide rural-urban disparity in healthcare (Sharma et al., 2018). In the southern part of the country, where there is higher female literacy and stronger healthcare delivery systems in addition to higher urbanisation, infertility rates tend to be lower. Nevertheless, delayed childbirth in educated urban women in southern states such as Tamil Nadu and Kerala is leading to increased cases of infertility attributable to endometriosis, decreased ovarian reserve, and male factor infertility (Chandra et al., 2014). Western India shows an uneven pattern with urban areas such as Mumbai and Pune showing lifestyle-related cases of PCOS and use of ART whereas rural Gujarat and Rajasthan have maintained their traditional aetiology pattern. The northeastern part of India is one of the underrepresented areas. High STIs, which include HIV in some sub-groups, along with low healthcare availability and unique tribal cultural practices, lead to higher infertility cases, but data on the same from this area are lacking (Unisa, 1999).

Temporal Trends in Female Infertility

The presence of inconsistent national surveillance in tracking time-based trends of infertility among women in India makes the process difficult; however, there are some clear patterns that can be identified through NFHS cycles and clinical registry reviews. There is a decline in total fertility rates from 2.7 in NFHS-3 (2005-2006) to 2.0 in NFHS-5 (2019-2021); there was an

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increase in the average age of mothers at first birth, especially in urban locations (MoHFW, 2021). It is clear that these trends are in agreement with an increased share of both age infertility and childlessness due to choice, leading to the overall observed rates of childlessness. Prevalence of PCOS seems to be on the rise and this trend is global and has been attributed to the increase in levels of overweight and obesity, physical inactivity, and changes in diets associated with the epidemiological transition in India (Bhattacharya & Jha, 2010). Improved control over TB in several states with reduced TB notifications could have reduced FGTB infertility over time.There has been significant growth in the use of ART in India over the last two decades. India is currently one of the biggest markets for IVF and other related treatments, where it is estimated that there are 2,000 to 2,500 clinics practicing ART in various parts of India by the mid-2020s (Indian Society for Assisted Reproduction [ISAR], 2022). Nonetheless, the spatial distribution of ART clinics is heavily concentrated within metropolitan cities, and cost issues continue to limit most infertile couples from accessing these services. Legislation concerning Assisted Reproductive Technology and Surrogacy was enacted in 2021 to govern their practices in favour of patients and donors, respectively (MoHFW, 2022).

Socioeconomic and Policy Dimensions

In the case of India, female infertility is entrenched within the socio-economic fabric of society. Poorer women are more prone to infertility from infections but lack access to proper healthcare for diagnosis and treatment. As reported by Reproductive Health Matters, poorer women experiencing fertility issues had low rates of visiting specialists compared to wealthier women who used traditional healers or other unorthodox practitioners (Dyer et al., 2004). Psychosocial issues, including domestic violence, desertion, and psychological problems, tend to impact economically disadvantaged women more significantly. The policy direction of India's national health system has been focused on reducing fertility rates rather than managing infertility. Infertility-related services are not considered essential services under the National Health Mission (NHM) and reproductive health programs (MoHFW, 2022). Advocacy efforts by professional bodies such as the Federation of Obstetric and Gynaecological Societies of India (FOGSI) and ISAR have increasingly highlighted the need for infertility to be recognised as a public health priority deserving of policy attention and resource allocation.

DISCUSSION

The epidemiology of female infertility in India demonstrates considerable burden, multifactorial etiology, and significant geographic and socio-economic diversity. There are several important points from this review that need to be considered for action. Firstly, the simultaneous presence of the factors that contribute to infertility due to infections and poor nutrition in rural India, and poor lifestyle choices and endocrine issues in urban India makes it clear that there cannot be one universal strategy for tackling the problem. The public health approach needs to be tailored to specific locations. Secondly, the infrastructure to support the surveillance of infertility in India needs to be developed urgently. The use of indirect measurements and convenience sampling leads to unreliable and non-comparable figures. Population-based surveys using standardized definitions of infertility, diagnostic criteria, and stratified analyses based on state, rural/urban setting, and socioeconomic status should be conducted in order to have informed policymaking based on evidence. Thirdly, the huge psycho-social burden that women bear due to infertility requires mental health interventions to be integrated into the infertility care process. There is a need for stigma reduction, public education, and training of primary health workers in how to provide sensitive and compassionate counseling to infertile patients. Lastly, the growth of the ART sector in India, although increasing accessibility to ARTs to many women, raises concerns of potential abuse and exploitation of vulnerable women, as well as unequal access to ART services across regions. Strong enforcement of the ART Regulation Act of 2021 and integrating basic infertility screening within the public healthcare system can help address these challenges.

CONCLUSION

The problem of female infertility in India is multi-faceted and determined by a host of different biological, environmental, socio-cultural, and health-care system-related issues. This review has shown that infertility is a significant problem among Indian women and its prevalence varies significantly depending on the particular area of India due to different etiological patterns and levels of access to health care. In particular, the states located in northern and eastern India have high levels of infertility caused by infectious and nutritional reasons while urbanized areas see a rise in aetiology related to lifestyle factors. The changes in time indicate that there is a shift in etiology which corresponds to the demographic transition in India. To address this problem effectively, it is necessary to move beyond fragmented approach focusing solely on clinical aspects to an integrated strategy targeting prevention, early diagnosis, equal treatment opportunities, and psychological support. In this context, it is important to strengthen national surveillance systems, promote infertility services at the national level, regulate the use of assisted reproductive technologies, and incorporate fertility into reproductive health policy framework.

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