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A PROSPECTIVE STUDY TO EVALUATE THE ETIOLOGICAL FACTORS OF FEMALE INFERTILITY AND TO ASSESS THE TUBAL FACTORS IN TERTIARY CARE HOSPITAL IN SOUTH RAJASTHAN

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ABSTRACT

Introduction: Infertility is a major global public health concern with significant medical, psychological, and social implications. It is multifactorial, with both male and female factors contributing. Tubal pathology remains a leading cause in low- and middle-income countries. Region-specific studies are essential for guiding management. This study aimed to evaluate the etiological factors of female infertility and assess the contribution of tubal pathology in women attending a tertiary care hospital in South Rajasthan.

Materials and Methods: A prospective cohort study was conducted from May 2023 to April 2024 in the Department of Obstetrics and Gynecology, Pacific Institute of Medical Sciences, Udaipur. A total of 100 infertile women aged 20–40 years were enrolled based on defined criteria. Data on demographic, menstrual, and reproductive profiles were collected. All participants underwent transvaginal ultrasonography (TVS) and hysterosalpingography (HSG), with selected cases evaluated using diagnostic hysterolaparoscopy. Hormonal assays were performed, and male partners underwent semen analysis. Data were analyzed using SPSS v26, with results expressed as frequencies, percentages, sensitivity, and specificity.

Results: The mean age of participants was 29.6 years; most were 21–30 years (50%) or 31–40 years (46%). Secondary infertility (63%) was more prevalent than primary infertility (37%). Tubal factors included endometriosis (25%), chronic pelvic inflammatory disease (24%), prior tubal surgery (23%), ectopic pregnancy (21%), and tuberculosis (14%). Male factor infertility was observed in 32% of couples. Abnormal USG/HSG findings were seen in 53% of women. Female imaging demonstrated limited predictive value for male infertility (sensitivity 59.4%, specificity 50%).

Conclusion: Infertility in South Rajasthan is marked by predominant secondary infertility, significant tubal pathology, and notable male contribution. Comprehensive evaluation of both

partners and preventive measures targeting pelvic infections and modifiable risk factors are essential to improve outcomes.

Keywords: Female infertility, Tubal factors, Secondary infertility

INTRODUCTION

Infertility is increasingly recognized as a major global public health concern, cutting across social, cultural, and geographic boundaries [1]. According to the World Health Organization (WHO), it is defined as the failure to achieve clinical pregnancy after 12 months or more of regular, unprotected sexual intercourse in women under 34 years, and after 6 months in women aged 35 years and above [2]. Infertility is broadly classified into primary infertility, where a woman has never conceived, and secondary infertility, where conception has occurred previously, irrespective of pregnancy outcome. Globally, an estimated 10–15% of reproductive-aged couples are affected, with a burden of nearly 50–80 million individuals struggling to conceive [3].

The consequences of infertility extend beyond medical dimensions, often leading to psychological stress, social stigma, marital discord, and financial strain, particularly in low- and middle-income countries [4]. Although almost half of couples may eventually conceive within two years without intervention, factors such as delayed childbearing, urbanization, lifestyle changes, and environmental exposures have increased the demand for fertility evaluations and assisted reproductive technologies (ART) [5]. Despite advances in treatment modalities, infertility remains undertreated in many developing regions due to cultural taboos, lack of awareness, and limited access to specialized healthcare services [1].

In India, infertility poses a unique challenge. National Family Health Survey (NFHS) data indicate a marginal decline in prevalence; however, the absolute number of affected couples remains substantial due to the country's large population base [6]. Moreover, infertility is heavily influenced by cultural expectations, where a woman's identity and social value are often tied to her ability to conceive, especially to bear sons [7]. In states like Rajasthan, socio-demographic factors such as early marriage, lower literacy rates among women, limited reproductive healthcare access, and low socioeconomic status further exacerbate the problem [8]. The burden is compounded by the tendency to attribute infertility solely to women, exposing them to social exclusion, psychological trauma, and even domestic violence [9].

The etiology of infertility is complex and multifactorial, encompassing female factors (ovulatory dysfunction, diminished ovarian reserve, tubal damage, uterine anomalies, endometriosis), male factors (sperm abnormalities, hormonal imbalances), combined causes, and unexplained infertility [10]. Among women, tubal factors remain one of the leading contributors, often secondary to pelvic inflammatory disease, endometriosis, tuberculosis, prior surgeries, or ectopic pregnancy [11]. Hormonal imbalances such as polycystic ovary syndrome, thyroid disorders, and hyperprolactinemia also play a significant role in disrupting ovulatory cycles and fertility potential [12]. Understanding the distribution of these factors within specific populations is vital to guide targeted interventions.

Given the complex interplay of biological, social, and cultural determinants, region-specific studies are essential for mapping infertility patterns and tailoring appropriate management strategies. In this context, the present study was undertaken at a tertiary care hospital in South Rajasthan with the objective of determining the causes of primary and secondary infertility, and specifically to evaluate female patients with histories of tuberculosis, chronic pelvic inflammatory disease, ectopic pregnancy, endometriosis, or prior tubal surgery.

MATERIALS AND METHODS

This prospective cohort study was conducted in the Department of Obstetrics and Gynecology, Pacific Institute of Medical Sciences (PIMS), Umarda, Udaipur, Rajasthan, from May 2023 to April 2024. The objective was to evaluate etiological factors of female infertility and assess tubal factors

in women attending the infertility outpatient department. A total of 100 couples were enrolled after applying strict eligibility criteria.

Women aged 20–40 years, married for over one year, cohabiting with their husbands, and not using contraception were included. Husbands had to have normal semen analysis. Secondary infertility cases, defined as failure to conceive after a previous pregnancy without contraception, breastfeeding, or postpartum amenorrhea for two years, were also eligible. Exclusion criteria were women undergoing in-vitro fertilization (IVF), abnormal semen analysis in the male partner, and refusal to participate. Written informed consent was obtained from all participants, and confidentiality was maintained.

Sample size was calculated using the formula for sample estimation with population proportion, degree of accuracy, and chi-square values at a 95% confidence level, which yielded 100 participants. Data were collected through structured proformas documenting menstrual history, contraceptive use, infertility treatment history, family history, lifestyle habits, allergies, and systemic conditions. Each participant underwent general examination, including vitals and systemic health, followed by abdominal, pelvic, and vaginal examinations.

Radiological evaluation of female participants included transvaginal ultrasonography (TVS) to assess uterine and ovarian morphology, and hysterosalpingography (HSG) to evaluate tubal patency. In selected cases, diagnostic hysterolaparoscopy (DHL) was performed for further assessment of uterine and tubal abnormalities. Hormonal assays included follicle-stimulating hormone (FSH), luteinizing hormone (LH), prolactin (PRL), progesterone, testosterone, and thyroid hormones (T3, T4, TSH), to evaluate ovarian reserve, ovulatory function, and endocrine status. Male partners underwent semen analysis for count, motility, and morphology; abnormal reports were further investigated with hormonal or genetic testing.

Follow-up visits monitored treatment response, changes in fertility parameters, and provided counselling and individualized management. Data were analyzed using SPSS version 26.0. Categorical variables were summarized as frequencies and percentages, while continuous variables were expressed as mean and SD. The diagnostic performance of study variables was assessed by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

RESULTS

The majority of infertile women in this study were in the active reproductive age group of 21–30 years (50%) and 31–40 years (46%), with a mean age of 29.65 years. Only 4% were younger than 20 years, indicating that most women sought infertility evaluation after their twenties. Socio-economic distribution revealed that more than half of the participants belonged to the middle class (56%), followed by the low socio-economic group (37%), while only a small proportion came from higher strata (7%). Regarding menstrual history, most women reported regular cycles (81%), while irregular cycles were present in 19%, suggesting that menstrual disturbance was not the predominant presentation among these women (Table 1).

Table 1. Demographic Profile of Infertile Women (n = 100)

Variable	Category	No. (%)
Age group (years)	**≤20**	4 (4%)
	21–30	50 (50%)
	31–40	46 (46%)
Socio-economic status	**Low**	37 (37%)
	Middle	56 (56%)
	High	7 (7%)
Menstrual history	**Regular**	81 (81%)
	Irregular	19 (19%)

Among the clinical characteristics, the most common presenting complaint was inability to conceive, reported by 43% of women. Other frequent complaints included irregular menstrual cycles (23%), pelvic pain (15%), and recurrent miscarriages (15%), whereas lower abdominal discomfort was less common (4%). With respect to infertility type, secondary infertility (63%) was nearly twice as common as primary infertility (37%), suggesting that many women developed difficulty conceiving after one or more pregnancies. Analysis of contraceptive use showed that more than half of the participants had never used contraception (55%), while among users, oral contraceptive pills were the most common method (25%), followed by intrauterine devices (11%), barrier methods (6%), and injectables (3%) (Table 2).

Table 2. Clinical Characteristics of Infertile Women (n = 100)

Variable	Category	No. (%)
Chief complaints	**Inability to conceive**	43 (43%)
	Irregular periods	23 (23%)
	Pelvic pain	15 (15%)
	Recurrent miscarriage	15 (15%)
	Lower abdominal discomfort	4 (4%)
Infertility	**Primary infertility**	37 (37%)
	Secondary infertility	63 (63%)
History of contraceptive use	**None**	55 (55%)
	OCP	25 (25%)
	IUCD	11 (11%)
	Barrier	6 (6%)
	Injectables	3 (3%)

Assessment of etiological factors highlighted the significant contribution of tubal pathology in infertility. Endometriosis was the leading tubal factor (25%), closely followed by chronic pelvic inflammatory disease (24%), prior tubal surgery (23%), and ectopic pregnancy (21%). Tuberculous salpingitis was also an important cause, seen in 14% of cases, reflecting regional epidemiological patterns. Male factor infertility was observed in 32% of couples based on semen analysis. Furthermore, abnormal findings on ultrasound or hysterosalpingography were identified in 53% of women, emphasizing the high prevalence of structural or anatomical abnormalities contributing to infertility (Table 3).

Table 3. Etiological Factors of Infertility (n = 100)

Etiological Factor		No. (%)
Tubal factors	**Endometriosis**	25 (25%)
	Chronic PID	24 (24%)
	Prior tubal surgery	23 (23%)
	Ectopic pregnancy	21 (21%)
	Tuberculosis	14 (14%)
Male factor	**Abnormal semen analysis**	32 (32%)
USG/HSG	**Abnormal findings**	53 (53%)

Hormonal evaluation of the participants showed mean FSH and LH levels of 6.72 ± 1.57 mIU/mL and 7.43 ± 1.89 mIU/mL, respectively, both within normal reproductive ranges. Prolactin levels averaged 13.47 ± 4.08 ng/mL, while thyroid hormone values were also within reference limits (T3: 1.23 ± 0.20 ng/mL, T4: 7.86 ± 1.42 µg/dL, TSH: 2.71 ± 1.18 µIU/mL). These findings indicate that gross endocrine dysfunction was uncommon in the study population, though hormonal assessment remained an essential part of the workup to rule out subclinical abnormalities (Table 4).

Table 4. Hormonal Profile of Infertile Women

Parameter	Mean ± SD
FSH (mIU/mL)	6.72 ± 1.57
LH (mIU/mL)	7.43 ± 1.89
PRL (ng/mL)	13.47 ± 4.08
T3 (ng/mL)	1.23 ± 0.20
T4 (µg/dL)	7.86 ± 1.42
TSH (µIU/mL)	2.71 ± 1.18

Correlation analysis between female imaging findings and male semen parameters revealed that among 53 women with abnormal USG/HSG results, 19 had partners with abnormal semen while 34 had normal semen reports. Conversely, among the 47 women with normal imaging, 13 had abnormal semen results and 34 had normal findings. The calculated sensitivity of USG/HSG in predicting abnormal semen analysis was 59.4%, with a specificity of 50.0%. The positive predictive value was relatively low at 35.8%, whereas the negative predictive value was higher at 72.3%, suggesting that a normal USG/HSG finding in the female partner was more likely to be associated with normal semen analysis in the male partner. These findings highlight the limited diagnostic concordance between female imaging and male semen factors, underscoring the importance of evaluating both partners in infertility workup (Table 5).

Table 5. Correlation of Female Imaging Findings and Male Semen Analysis

USG/HSG Findings	Abnormal Semen	Normal Semen	Total
Abnormal (n=53)	19	34	53
Normal (n=47)	13	34	47
Total	32	68	100

DISCUSSION

Infertility remains a multifactorial condition with profound medical, social, and psychological implications, particularly in low- and middle-income countries such as India. In our cohort, the majority of women were in their late twenties, aligning with the biological window of peak fertility. This is consistent with prior studies from India and abroad, which also reported the highest infertility prevalence between 26–30 years [13-15]. However, some variability exists globally, with slightly younger presentation in rural populations by Soni M et al. [16]. These findings underscore how sociocultural expectations, access to healthcare, and evolving reproductive choices influence the age at which infertility evaluation is sought.

Socio-economic status in our study reflected a predominance of middle- and lower-income groups, echoing findings from Singh K et al. and Eraky EM et al. [13,17] Limited awareness, economic constraints, and reliance on public tertiary centers may explain this distribution. In contrast, private and urban-based studies such as Mayrhofer et al. (2024) documented a higher proportion of upper-income participants, highlighting disparities in healthcare-seeking behavior [18]. Our findings reinforce that infertility is not confined to any socio-economic class, but diagnosis and treatment are more commonly pursued by couples in middle- and low-income strata within public healthcare systems.

The clinical spectrum of presentation in our cohort was dominated by inability to conceive (43%), followed by menstrual irregularities and pelvic pain. This aligns with Singh K et al. and Eraky EM et al., where direct reproductive concerns were the most frequent reason for consultation, though coexisting gynecologic complaints often co-occurred [13,17]. Interestingly, secondary infertility was more common than primary infertility in our study, diverging from several Indian reports that documented a predominance of primary infertility by Singh K et al. and Anwar BR et al. [13,19] Our results are closer to Umeora OU et al. and Nanaware SS et al., where secondary infertility was attributed to postpartum infections, unsafe delivery practices, or sequelae of pelvic inflammatory

disease [20,21]. This trend highlights the continuing burden of preventable reproductive morbidity in resource-limited settings.

Tubal factors emerged as the leading etiological contributors, with endometriosis, PID, prior surgeries, ectopic pregnancies, and genital tuberculosis all playing substantial roles. This mirrors findings from Nanaware SS et al., Umeora OU et al., and Singh K et al., which consistently identify tubal pathology as a dominant cause in developing countries [13,20,21]. The contribution of genital tuberculosis is particularly notable in our context, underscoring the need for vigilance in endemic regions. Our data also demonstrate that a majority of women reported regular menstruation, suggesting that tubal and male factors, or unexplained infertility, may account for much of the burden even when menstrual history appears normal.

When examining male factors, 32% of partners exhibited semen abnormalities, comparable to published rates of 30–40% [13,14,20]. Importantly, the diagnostic association between female imaging abnormalities and male semen defects was modest, with a sensitivity of 59.4% and specificity of 50.0%. This reinforces the conclusion of Eraky EM et al. and Nanaware SS et al. that infertility evaluation must address both partners concurrently, and that female imaging findings alone cannot reliably predict male factor abnormalities [17,21]. While USG and HSG remain valuable first-line tools, their limitations compared to laparoscopy should be recognized.

The present study is limited by its single-center design, modest sample size, and reliance on basic imaging and single-timepoint hormonal and semen evaluations. More comprehensive diagnostic modalities, assessment of lifestyle and psychosocial determinants, and long-term follow-up of treatment outcomes would provide deeper insights. Nonetheless, our findings add to the growing body of evidence that infertility in semi-urban Indian populations is characterized by a predominance of secondary infertility, significant tubal pathology, and a substantial though not dominant contribution of male factors. Collectively, these results emphasize the need for preventive reproductive health strategies, early detection of pelvic infections, and integrated couple-based evaluation to improve infertility care outcomes.

CONCLUSION

This study underscores the multifactorial etiology of infertility and the necessity for comprehensive evaluation of both partners. Secondary infertility was more prevalent than primary infertility, with the majority of women affected belonging to the 26–30 years age group and predominantly from middle socio-economic backgrounds. Despite largely regular menstrual cycles and normal hormonal profiles, tubal factors such as endometriosis, chronic pelvic inflammatory disease, and prior ectopic pregnancies were frequently identified. Importantly, the diagnostic performance of USG/HSG findings in predicting male factor infertility was limited, as a considerable proportion of male partners demonstrated abnormal semen parameters despite normal female imaging. These findings highlight that infertility evaluation cannot rely solely on female imaging or isolated investigations but must instead involve concurrent, individualized, and thorough assessment of both partners. Greater emphasis on early detection, prevention of pelvic infections and surgical trauma, and management of modifiable risk factors is essential for improving reproductive outcomes.

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