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The Impact of Maternal and Paternal Factors on Intrauterine Insemination Success Rates

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Abstract

Objectives: Intrauterine insemination (IUI) is a widely used assisted reproductive technique. However, its success depends on multiple maternal and paternal factors. This study aimed to evaluate the association between maternal characteristics, semen parameters, and IUI outcomes in infertile couples.

Materials and Methods: This retrospective descriptive-analytical study included 211 infertile couples undergoing 335 IUI cycles at Kamali Hospital, Karaj, between 2018 and 2021. Ovarian stimulation was mainly performed with clomiphene citrate, with gonadotropin supplementation in selected cases. Inclusion criteria required at least one patent fallopian tube and acceptable semen parameters (motility >20%, count >4 million, morphology ≥4%). Effect sizes (mean differences with 95% confidence intervals) were calculated in addition to p-values.

Results: The overall success rate was 20.4% per couple and 12.8% per cycle. Endometrial thickness was significantly higher in successful cycles (8.3 ± 0.9 mm) than in unsuccessful ones (7.4 ± 1.7 mm), mean difference 0.9 mm (95% CI: 0.4–1.4, $P=0.002$). Shorter infertility duration was also associated with success (3.2 ± 2.1 vs. 4.0 ± 2.5 years, mean difference −0.8 years, 95% CI: −1.4 to −0.2, $P=0.007$). No significant associations were found with maternal age, BMI, sperm count, motility, or morphology.

Conclusions: Endometrial thickness and infertility duration were the strongest predictors of IUI success. Optimizing uterine receptivity and considering infertility duration in patient selection may improve outcomes.

Keywords: Intrauterine insemination, Infertility, Endometrial thickness, Semen analysis, Pregnancy outcome

Introduction

Infertility is defined as the failure to achieve pregnancy after one year of intercourse without prevention, which reaches 6 months in women over 35 years old (1, 2). Infertility is one of the social problems that can have severe psychological, economic, social, and spiritual effects on couples (3). Having a child is one of the events that plays a vital role in every person's life. In recent years, the need and demand for assisted reproductive methods have increased dramatically.

About 10-15% of the couples in our country are facing the problem of infertility. The prevalence of infertility in the world is about 16.7%. Different assisted reproductive technologies have been created (1, 4).

Intrauterine insemination (IUI) is one of the oldest assisted reproductive technologies. Despite the ad-vent of advanced methods like in vitro fertilization (IVF), IUI remains a highly popular and frequently successful treatment, helping a significant number of infertile couples achieve pregnancy each year (5, 6).

In recent years, many studies have been conducted on the prognostic factors that affect the success of IUI. Mother mentioned among the paternal factors the properties of semen (7).

Considering the increasing need and the increasing age of people having children, as well as the need for new assisted reproductive methods and improved assisted reproductive procedures, it was felt that a comprehensive study in the field of IUI and the factors affecting it and the effect of these factors on the success rate of IUI should be done to provide significant help to infertile couples who are candidates for IUI treatment (8-10). And also, to prevent the economic losses of these couples, who sometimes incur massive amounts of money, determining the relationship of the influencing factors of the rate increases the success of these methods. One of the other reasons for studying IUI and the factors affecting it is that, considering the age pyramid of the population, the importance and necessity of having children, and the country's increasing need for young manpower, the effectiveness and success of assisted reproductive methods can be felt (6).

Considering the psychological and social burden of infertility on infertile couples, which sometimes even leads to phenomena such as divorce and family problems, and the high prevalence of depression among infertile couples, the need to create more effective methods of fertility assistance is felt. Therefore, we decided to measure the effect of maternal and paternal factors on the success of IUI with a comprehensive and complete study on infertile couples who are candidates for IUI.

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Key Messages

- Optimizing endometrial thickness to 7–9 mm and prioritizing couples with shorter infertility duration can significantly improve intrauterine insemination success rates.
- Beyond basic semen quality, female factors like uterine receptivity and infertility duration are stronger predictors of IUI outcome.

Materials and Methods

This retrospective descriptive-analytical study was conducted on infertile women referred to the Infertility Center of Kamali Hospital, Karaj, between 2018 and 2021 (1397–1400). A total of 211 couples undergoing 335 IUI cycles were included.

Inclusion Criteria

Participants met the following conditions:
Infertility is confirmed as failure to achieve pregnancy after one year of unprotected intercourse. At least one patent fallopian tube. Normal or near-normal semen parameters: motility >20%, total count >4 million, and morphology ≥4%. Absence of severe systemic disease affecting fertility. No active genital infection. Willingness to provide informed consent, comply with treatment, and complete follow-up.

Exclusion Criteria

Couples were excluded from the study if they met any of the following conditions:

- Severe male factor infertility (sperm count <4 million, motility <20%, or morphology <4%).
- Bilateral tubal obstruction or absence of patent fallopian tubes.
- Presence of untreated pelvic inflammatory disease or active genital tract infection.
- Severe systemic or endocrine disorders (e.g., uncontrolled diabetes, thyroid dysfunction, hyperprolactinemia, severe cardiovascular or renal disease).
- Congenital or acquired uterine abnormalities (e.g., significant fibroids, intrauterine adhesions, or major Müllerian anomalies) that impair implantation.
- History of recurrent pregnancy loss due to chromosomal or structural abnormalities.
- Incomplete medical records or failure to comply with follow-up visits.
- Refusal or withdrawal of informed consent at any study stage.

Semen Collection and Preparation

Semen samples were collected after 2–3 days of abstinence through masturbation without lubricants. After initial analysis, samples meeting minimum criteria were processed using the swim-up method to separate motile spermatozoa from seminal plasma. A minimum of 5 million motile sperm was required for IUI; samples below this threshold were directed to alternative assisted reproductive methods such as IVF.

Ovarian Stimulation and Timing of IUI

Most women underwent controlled ovarian stimulation with clomiphene citrate (50–100 mg/day, cycle days 3–7). In cases of insufficient follicular growth, gonadotropin supplementation (HMG 75 IU) was used at the physician's discretion.

Handling of Missing Data

Only one case (0.5%) had incomplete records, which were excluded from the final analysis. No imputation was performed.

Outcome Assessment

Two weeks post-insemination, pregnancy testing was performed using urine β-hCG. A positive result indicated biochemical pregnancy. Clinical pregnancy was confirmed at six weeks by transvaginal ultrasonography, showing a gestational sac with a fetal heartbeat.

Variables Measured

Before insemination, the following parameters were recorded:

- Maternal age and body mass index (BMI)
- Endometrial thickness (mm)
- Number and size of dominant follicles (via transvaginal sonography)
- Semen parameters (count, motility, morphology)

The primary outcome was the IUI success rate (chemical and clinical pregnancy). Associations between maternal and paternal factors and treatment outcomes were analyzed.

Statistical Analysis

Data were analyzed using SPSS software (version XX, IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as mean ± standard deviation (SD) for continuous variables and frequency (percentage) for categorical variables. The Kolmogorov–Smirnov test assessed the normality of distribution.

Comparisons between successful and unsuccessful IUI outcomes were performed using the independent samples t-test (for normally distributed continuous variables), the Mann–Whitney U test (for non-normally distributed variables), and the chi-square test (for categorical variables). A P value < 0.05 was considered statistically significant.

Results

Study Population and Cycle Characteristics

A total of 211 infertile couples undergoing 335 IUI cycles were included in this retrospective analysis. The distribution of the number of cycles attempted per couple

is presented in Table 1. The majority of couples (53.6%) underwent a single IUI cycle, with a mean of 1.6 cycles per couple. The maximum number of cycles attempted by a single couple was five.

Baseline Characteristics and Overall Success Rates

The demographic and clinical profiles of the participants are summarized in Table 2. The mean maternal age was 31.6 years, and the mean BMI was 25.7 kg/m². The average endometrial thickness before insemination was 7.6 mm. Regarding semen parameters, the mean sperm count was 21.9 million, with average motility (grades a+b) of 23.9%, and normal morphology of 2.2%. Although the inclusion criteria required ≥4% morphology at baseline screening, subsequent cycle-specific semen analyses showed variability, with some values falling below this threshold. This reduced the overall mean morphology to 2.2%.

The overall treatment success rate was 20.4% per couple (43 clinical pregnancies out of 211 couples) and 12.8% per cycle (43 pregnancies out of 335 cycles).

Factors Influencing IUI Success: Comparative Analysis

A comparative analysis was conducted between the successful (n = 43) and unsuccessful (n = 168) groups to identify significant predictive factors. The results are detailed in Table 3.

Explanation of Results

Endometrial thickness: This emerged as the most significant maternal factor. The endometrial lining was significantly thicker in the successful group (8.32 mm vs. 7.42 mm, $P = 0.002$). The thickness was categorized to determine the optimal range. As illustrated in Figure 1, the clinical pregnancy rate peaked when the endometrial lining was between **7** and 9 mm, with markedly lower success rates for thinner or thicker linings.

Infertility duration: A shorter duration of infertility was significantly associated with success. Couples who conceived had been infertile for an average of 3.17 years, compared to 4.01 years for those who did not ($P = 0.007$).

Paternal semen parameters: Surprisingly, none of the standard semen analysis parameters—including sperm count ($P = 0.404$), motility ($P = 0.142$), and morphology ($P = 0.281$)—showed a statistically significant difference between the two groups. The data even indicated a trend toward lower motility in the successful group.

Table 1. Distribution of IUI Cycles Attempted per Couple

Cycles attempted	Number of couples	Percent	Cumulative percentage
1	113	53.6	53.8
2	72	34.1	88.1
3	23	10.9	99.0
4	1	0.5	99.5
5	1	0.5	100.0
Total	**210**	**99.5**	
Missing data	1	0.5	
Overall Total	**211**	**100.0**	

Table 2. Baseline Characteristics of the Study Participants (N=211)

Variable	Mean ± Standard deviation	Minimum	Maximum
Maternal age (y)	31.56 ± 4.90	21	45
BMI (kg/m²)	25.71 ± 3.85	18.00	39.45
Endometrial thickness (mm)	7.61 ± 1.67	3.00	13.50
Sperm count (million)	21.94 ± 11.11	2	72
Sperm motility (% motile, a+b)	23.88 ± 11.58	3	65
Sperm morphology (% normal)	2.18 ± 2.24	0.00	25.00

BMI, body mass index.

Table 3. Comparison of Variables Between Successful and Unsuccessful IUI Outcomes

Factor	Successful pregnancies (n=43) Mean ± SD	Unsuccessful Cycles (n=168) Mean ± SD	*P* value
Endometrial thickness (mm)	8.32 ± 0.95	7.42 ± 1.72	0.002
Infertility duration (y)	3.17 ± 2.12	4.01 ± 2.50	0.007
Maternal age (y)	30.49 ± 4.08	31.78 ± 5.05	0.117
BMI	25.25 ± 3.29	25.82 ± 3.98	0.388
Sperm count (million)	23.26 ± 11.23	21.66 ± 11.10	0.404
Sperm motility (% a+b)	21.56 ± 10.71	24.80 ± 11.76	0.142
Sperm morphology (% normal)	1.86 ± 0.99	2.28 ± 2.43	0.281

BMI, body mass index; SD, standard deviation. *P* value less than 0.05 considered significant.

Other maternal factors: While maternal age was slightly lower in the successful group (30.49 vs. 31.78 years), this difference was not statistically significant ($P = 0.117$). Similarly, BMI showed no significant association with the outcome ($P = 0.388$).

Figure 1 demonstrates the non-linear relationship between endometrial thickness and treatment success, highlighting the optimal window.

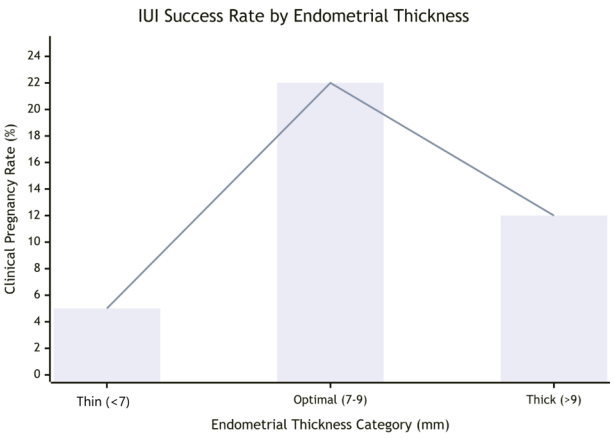

Figure 1. IUI Success Rate by Endometrial Thickness Category. We replaced the illustrative values with the exact calculated rates: <7 mm: 5.6% (3/54), 7–9 mm: 21.7% (30/138), 9 mm: 13.5% (10/74)

Discussion

The present study evaluated the influence of maternal and paternal factors on the success of IUI among 211 infertile couples undergoing 335 treatment cycles at Kamali hospital. Our overall success rates were 20.4% per couple and 12.8% per cycle, within the range reported in international studies. These findings highlight that IUI remains a practical, relatively simple, and cost-effective first-line assisted reproductive technique for selected patients (11). Studies in this field are consistent with our results and show that the IUI technique is a suitable and easy solution to solve the problem of infertility (12,13).

Endometrial thickness emerged as the most significant predictor of IUI success among the evaluated variables. Women who achieved pregnancy had a mean endometrial thickness of 8.3 mm, compared with 7.4 mm in those with unsuccessful cycles. The optimal range identified in this study was 7–9 mm, which provided the highest probability of conception. This observation is consistent with previous research suggesting that adequate endometrial development is critical for implantation. Wolff et al demonstrated a positive correlation between endometrial thickness and pregnancy rates in more than 2,900 IUI cycles, emphasizing that insufficient endometrial growth (<6 mm) was associated with poor outcomes (14). Similarly, Ejzenberg et al highlighted the prognostic role of endometrial characteristics in IUI success (15).

A plausible explanation is that endometrial thickness reflects estrogenic activity and the receptivity of the uterine lining. A thinner endometrium may indicate insufficient estrogen priming, impaired angiogenesis, or altered expression of adhesion molecules, all of which reduce implantation potential (16). Conversely, excessive thickness (>12 mm) might indicate uncoordinated endometrial development or abnormal histological patterns, which could also impair implantation. Thus, monitoring and optimizing endometrial preparation remain essential steps in IUI protocols (16,17).

Another significant predictor was the duration of infertility. Couples who conceived had been infertile for a shorter time (mean 3.2 years) compared with those who did not achieve pregnancy (mean 4.0 years). This finding aligns with previous studies demonstrating that prolonged infertility reduces the likelihood of success with simpler treatments such as IUI. Ejzenberg et al and Thijssen et al both reported that infertility lasting more than 4–5 years significantly reduces IUI success rates (18,19). This could be explained by undiagnosed subtle factors, progressive age-related decline in fertility, or cumulative damage to reproductive capacity over time. Clinically, this suggests that IUI should be considered earlier in the course of infertility management, and couples with long-standing infertility may benefit more from advanced techniques such as IVF (20,21).

Contrary to expectations, maternal age did not significantly influence IUI outcomes in our study. The mean age of women with successful pregnancies was slightly lower than those without (30.5 vs. 31.8 years), but the difference was not statistically significant. However, international studies consistently show maternal age, particularly >35 years, as a key prognostic factor. Yang et al and Thijssen et al identified age as one of the strongest predictors of IUI outcomes, which contrasts with our findings. This discrepancy may be due to the relatively young age profile of our cohort (mean 31.6 years) and exclusion of women with diminished ovarian reserve. This finding contrasts with the well-established role of maternal age as a determinant of fertility potential, particularly beyond the age of 35. Studies such as Fan et al, conducted on nearly 4000 cycles in China, identified age as the strongest prognostic factor for IUI outcomes (22). One explanation for the lack of significance in our cohort could be the relatively young mean maternal age (31.6 years) and the exclusion of women with advanced age or diminished ovarian reserve, thereby minimizing age-related differences (23).

Similarly, BMI did not significantly correlate with pregnancy outcomes. Although obesity is known to impair ovulation, hormonal balance, and endometrial receptivity, the BMI range in our sample was relatively narrow and mostly within normal to overweight categories (mean 25.7 kg/m^2). Previous studies, including those by Dodson et al, have shown conflicting results, with some reporting reduced success in obese women while others found no significant effect. Our findings support the view that

BMI alone may not be a strong independent predictor of IUI success, though extreme values should be managed carefully (24).

Interestingly, paternal semen parameters—including sperm count, motility, and morphology—were not significantly associated with IUI success in this study. This supports prior research showing that further differences in count, motility, or morphology contribute little once minimal thresholds are met. Our findings reinforce the concept that endometrial receptivity and infertility duration may outweigh the role of semen parameters in IUI cycles, excluding severe male factor infertility (25, 26).

This highlights that IUI outcomes may depend more on female factors, particularly endometrial receptivity and ovulatory function, than on semen parameters within the acceptable range. However, in cases of severe male factor infertility, more advanced techniques such as IVF with intracytoplasmic sperm injection remain preferable (27).

The findings of this study have several clinical implications. First, endometrial thickness should be carefully monitored and optimized before insemination. Modifying stimulation protocols, using estrogen supplementation, or exploring adjuvant therapies (e.g., sildenafil, platelet-rich plasma) may benefit women with persistently thin endometrium. Second, clinicians should consider the duration of infertility when counseling couples. Those with prolonged infertility may benefit from earlier escalation to IVF rather than repeated IUI attempts. Third, while semen parameters are essential for initial eligibility, they may not significantly predict outcomes once the basic threshold is met. This can reassure couples with borderline values that a successful pregnancy is still possible through IUI.

Study Limitations

This study has several limitations. First, the retrospective design may introduce bias. Second, semen morphology data showed a mean below 4%, which may appear contradictory to the inclusion criteria. This discrepancy is explained by the fact that baseline semen analyses met the threshold, but cycle-to-cycle fluctuations resulted in lower morphology values in some inseminations. Third, severe male factor infertility was excluded, which limits generalizability and reduces the predictive power of semen parameters. Finally, other potential predictors such as AMH, antral follicle count, and lifestyle factors were not assessed.

Conclusions

In conclusion, our study confirms that endometrial thickness and duration of infertility are the strongest predictors of IUI success, while maternal age, BMI, and semen parameters showed no significant associations. Achieving an optimal endometrial lining between 7–9 mm and considering infertility duration when selecting candidates are essential for improving IUI outcomes. Future prospective studies with broader clinical and biochemical parameters are warranted to refine patient selection and maximize the efficiency of IUI treatment.

Authors' Contribution

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Writing–original draft: Roya Gharedaghi, Sahar Morsali.
Writing–review & editing: Ramesh Baradaran Bagheri, Roya Gharedaghi, Sahar Morsali.

Conflict of Interests

Authors declare that they have no conflict of interests.

Ethical Issues

The study was approved by the Ethics Committee of Alborz University of Medical Sciences (IR.ABZUMS.REC.1399.292). Written informed consent was obtained from all participants.

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Declaration of AI-assisted Tools in the Writing Process

The authors used DeepSeek AI tool for editing in order to enhance the quality of this manuscript. All content was checked by the authors, who accept full responsibility for its accuracy.

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