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Intracytoplasmic Sperm Injection (ICSI), Embryo Transfer, Maternal BMI and Oocyte Quality: Implications for IVF Protocol Study on Live Birth Outcomes

Yash Srivastav[1*], Shivani Singh[1], Kamini Prajapati[1], Brijesh Kumar Pal[1], Stuti Verma[2], Saroj Kumar[1]

[1]D.K.R.R Pharmacy College, Amberpur, Sitapur (Uttar Pradesh), India

[2]Aryakul College of Pharmacy and Research, Sitapur, Uttar Pradesh, India

***Corresponding Email: yashsrv.108@gmail.com**

Abstract:

Infertility is becoming an increasingly common reproductive health condition globally, leading to a dramatic increase in the use of assisted reproductive technologies, including intracytoplasmic sperm injection (ICSI) and in vitro fertilisation (IVF). Numerous factors, such as the mother, the embryo, and the IVF procedure, contribute to the success rate of in vitro fertilisation (IVF) and live births. Investigated here are in vitro fertilisation (IVF) success rates as a function of oocyte quality, maternal body mass index (BMI), embryo transfer methods, and ICSI. Female infertility patients undergoing in vitro fertilisation procedures at assisted reproduction centres were the subjects of the study, which used a quantitative methodology. Embryonic factors were considered alongside age, BMI, oocyte shape, fertilisation, embryo growth, embryo implantation rate, and pregnancy success rates. A chi-square test, descriptive statistics, regression models, and correlation analyses were all used to analyse the data statistically. The results show that the mother's oocyte quality and body mass index (BMI) significantly affect live birth rates, embryo growth, embryo implantation rate, and fertilisation success. There was a correlation between poor oocyte quality and high maternal BMI, lower rates of IVF success, and lower chances of live births.

Keywords: Intracytoplasmic sperm injection, ICSI, IVF, embryo transfer, maternal BMI.

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1. INTRODUCTION

There are a lot of variables, including changes in lifestyle patterns, delayed motherhood, hormonal and metabolic imbalances, and environmental factors, that contribute to infertility, which affects millions of couples worldwide and has been on the rise over the years[1]. For infertile couples, infertility is a major source of financial, social, emotional, and psychological hardship[2]. Assisted reproductive technology (ART) and other medical therapies for infertility

management have come a long way in the last several decades, greatly improving pregnancy success rates and giving couples a fighting chance at conceiving successfully[3]. Both intrauterine insemination (IUI) and in vitro fertilisation (IVF) have a good chance of success depending on a number of factors, including those pertaining to the mother, the embryo, and the patient's health. Oocytes, fertilisation rate, embryo development, embryo transfer techniques, and the mother's Body Mass Index (BMI) are all part of this. Realising the impact of these factors on delivery outcomes4 is of the utmost importance[4].

1.1 Background of the Study

There are millions of couples impacted by infertility, and it has emotional, social, and economic ramifications as well as being a major concern in the field of reproductive health globally[5]. Some of the most efficient methods for treating infertility are assisted reproductive techniques, such as intracytoplasmic sperm injection (ICSI) and in vitro fertilisation (IVF)[6]. One essential stage in in vitro fertilisation (IVF) is embryo transfer, which may influence implantation and pregnancy outcomes[7]. Intracytoplasmic sperm injection (ICSI) involves injecting a single sperm directly into a mature egg[8]. Some of the elements that influence the likelihood of success include the embryo's quality, the preparedness of the uterus, and the time of the transfer[9]. The mother's body mass index (BMI) is another element that influences the outcome of the pregnancy[10].

Many consider the quality of the oocytes to be a strong predictor of embryonic viability and fertilisation success. The overall success rate could be negatively impacted by oocytes that are of poor quality or have aberrant chromosomal numbers. Nevertheless, there are still disparities in the live birth success rate, even though both IVF and ICSI have improved. Factors like as body mass index (BMI), oocyte quality, and the ICSI method all have a combined impact, which must be understood.

1.2 Statement of the Problem

Many individuals still deal with infertility issues such failed fertilisation or implantation, miscarriages, or problems after childbirth, even though IVF and ICSI have substantially increased the success rate of reproductive treatments. The precise correlation between the mother's body mass index (BMI), the quality of her oocytes, and the methods used to transfer embryos and the chances of a successful pregnancy require further investigation. But there's evidence that these factors can play a big role in deciding how well a reproductive strategy works. The problem is already complex for fertility doctors, and the increasing number of women who are overweight makes it even worse. Consequently, research into the parameters that influence the success rate of in vitro fertilisation, such as ICSI, embryo transfer procedures, maternal BMI, and oocyte quality, is crucial.

1.3 Objectives of the Study

- To determine how factors such as oocyte quality, embryo transfer methods, maternal BMI, and intracytoplasmic sperm injection (ICSI) affect the success rate of in vitro fertilisation (IVF).

- To determine whether there is a correlation between the birth weight of the mother and the quality of her eggs in in vitro fertilisation.
- To analyze the effect of oocyte quality on fertilization, embryo development, and implantation success.
- To find out what makes in vitro fertilisation (IVF) a good choice for a live birth.

1.4 Research Hypotheses

H1: Maternal BMI significantly affects live birth outcomes in IVF treatment.

H2: Oocyte quality is positively associated with fertilization success and embryo implantation rates.

H3: Optimized embryo transfer protocols significantly improve live birth outcomes among IVF patients.

H4: Intracytoplasmic sperm injection (ICSI) significantly enhances fertilization outcomes in selected infertility cases.

2. METHODOLOGY

The research methodology is detailed here. Its purpose was to study the effects of variables like intracytoplasmic sperm injection (ICSI), embryo transfer strategies, maternal body mass index (BMI), and oocyte quality on birth rates in women undergoing in vitro fertilisation (IVF) for infertility. This quantitative study examined the relationship between ART treatment success rate and a number of clinical and embryological factors.

2.1 Research Design

In the current study, a quantitative observational study design was employed in order to analyze the effect of ICSI, embryo transfer procedures, BMI of females, and quality of oocytes on the outcome of live births following treatment with IVF. This particular design was chosen to measure various clinical and embryological factors involved in successful pregnancies through assisted reproductive technology.

2.2 Study Setting

Fertility clinics and assisted reproductive technology (ART) centers that provided IVF and ICSI procedures were the settings of the study. When it came to treating infertility, the reproductive medicine and assisted reproductive technology centers had state-of-the-art embryology labs and divisions.

2.3 Participants and Sample Details

Infertile women undergoing IVF-ICSI treatment cycles made up the study subjects. Two hundred infertile patients were chosen for the study using a purposeful sampling method.

Criteria for Inclusion

- Women in the working-age bracket (20–40).

- People going through rounds of in vitro fertilisation and intracytoplasmic sperm injection.
- Women who have all of their embryological and clinical records.
- Individuals who are prepared to give their informed permission.

Inclusion Requirements

- Individuals suffering from serious metabolic or systemic diseases.
- Female patients whose medical histories are missing or inconsistent.
- Individuals participating in oocyte donation cycles.
- Pregnant women whose uterine anomalies impact the success of implantation.

2.4 Instruments and Materials Used

Data used in this study was acquired by employing structured data sheets from the clinical aspect, patient medical files, embryology lab results, hormonal assessment report and ultrasound results acquired from the center undertaking the IVF and ICSI treatments. Different laboratory devices and materials employed in the assisted reproduction process such as the equipment for both IVF and ICSI, embryo culture, incubators and egg quality grading techniques were employed in embryological assessment and treatments. The main dependent variables considered in this study include the age of mother, BMI of mother, cause and period of infertility, numbers of egg retrieved, quality of eggs, fertilization, embryo quality, embryo transfer technique, implantation and result of pregnancy.

2.5 Procedure and Data Collection Methods

Patients eligible for ovarian stimulation were assessed using hormonal tests and transvaginal ultrasonography. Maturity of the oocyte was confirmed by transvaginal aspiration and intracytoplasmic sperm injection (ICSI) of the oocyte. Post-injection fertilization and subsequent development of the embryo were carried out in vitro.

The quality of the embryos was determined morphologically prior to transferring the embryos into the uterus. Whether cleavage stage or blastocyst stage embryos were transferred was decided based on the regimen of treatment. The results of both clinical and live births were noted from the records of the follow-up visits made by the patients.

2.6 Data Analysis Techniques

Statistical Package for the Social Sciences (SPSS) was used to code, tabulate, and analyse the gathered data.

Statistical methods such as these were used:

- Statistics based on frequency and percentage
- Standard deviation and mean
- A chi-square analysis

- Analysing correlations
- Regression of logistical variables

For every analysis, a p-value below 0.05 was deemed statistically significant.

3. RESULTS

In this part, the results gathered after the data analysis will be discussed. These results were evaluated to see the effect of BMI, egg quality, fertilization, embryo transfer, and implantation on the live birth results of women who underwent ICSI treatment. Statistical techniques were used, and the results are presented in tabular form and graphically. These results can give an understanding of how clinical and embryological factors contribute to reproductive success after ICSI treatment.

3.1 Demographic and Clinical Characteristics of Participants

The demographics and medical data of the 200 individuals that were part of this investigation are shown in Table 1. You can see how the patients are distributed by age, BMI, and infertility cause in the table. In order to establish the demographic profile of the women who underwent IVF-ICSI therapy, these factors were taken into account throughout the analysis.

Table 1 Demographic and Clinical Characteristics of Participants

Variable	**Frequency (n)**	**Percentage (%)**
Age Group		
20–25 Years	32	16.0
26–30 Years	74	37.0
31–35 Years	61	30.5
36–40 Years	33	16.5
BMI Category		
Underweight	18	9.0
Normal BMI	96	48.0
Overweight	54	27.0
Obese	32	16.0
Cause of Infertility		
Male Factor	68	34.0
Female Factor	79	39.5
Combined Factor	36	18.0

Unexplained Infertility	17	8.5

The results showed that the age group of 26–30 years old had the highest percentage of participation (37.0%), followed by the age group of 31–35 years old (30.5%). There were 16.0% of participants in the 20–25 age bracket and 16.5% in the 36–40 age bracket. Almost half of the individuals (48.0%) had a normal body mass index (BMI), while a quarter were overweight and a sixteen percent were obese. Just 9.0% of the participants were underweight.

Among the factors that contribute to infertility, infertility in women accounted for 39.5% of cases, while in men it was 34.0%. The second-highest percentage was for combined infertility (18.0%), and the lowest was for unexplained infertility (8.5%).

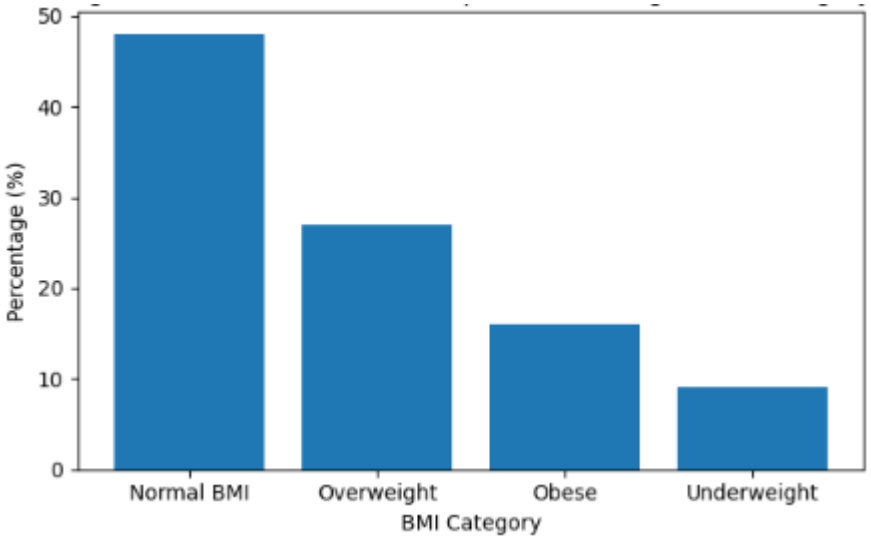

Figure 1: Distribution of participant According to BMI Category

Figure 1 shows how participants are distributed with regard to their BMI status. It is evident that the greatest number of women using fertility treatment was of normal BMI (48.0%). Overweight and obese individuals made up 27.0% and 16.0%, respectively. The smallest portion consisted of underweight participants who comprised only 9.0% of total participants.

This graph clearly reveals that there are many abnormal conditions relating to the BMI status and that women on fertility treatment may be at risk due to these abnormalities.

3.2 Relationship Between Maternal BMI and Oocyte Quality

The correlation between the mother's body mass index (BMI) and oocyte quality in women undergoing IVF-ICSI treatment is displayed in Table 2. This table compares the number of patients with good and bad oocyte quality and ranks them according on BMI. The significance of the link between body mass index (BMI) and oocyte quality was determined using the chi-square test.

Table 2 Association Between Maternal BMI and Oocyte Quality

BMI Category	Good Oocyte Quality	Poor Oocyte Quality	Total	p-value
Underweight	9	9	18	
Normal BMI	78	18	96	
Overweight	27	27	54	
Obese	11	21	32	
Total	**125**	**75**	**200**	**0.003**

It was observed that maternal BMI showed a significantly associated relationship with oocyte quality (p = 0.003). Good-quality oocytes were observed to be present more in cases where the women had normal maternal BMI with 78 good oocytes among a total sample size of 96. On the other hand, the overweight and obese groups showed comparatively less presence of good quality of oocytes. Poor quality of oocytes was observed in 21 obese participants among a total of 32 obese women. This shows that there is a direct influence of high BMI on reproductive characteristics.

Moreover, for overweight patients, equal proportions of good and poor quality of oocytes were observed. Poor reproductive results were also shown by underweight participants with similar proportions of good and poor oocytes. Thus, it can be said that maternal BMI affects the oocyte quality during IVF treatment.

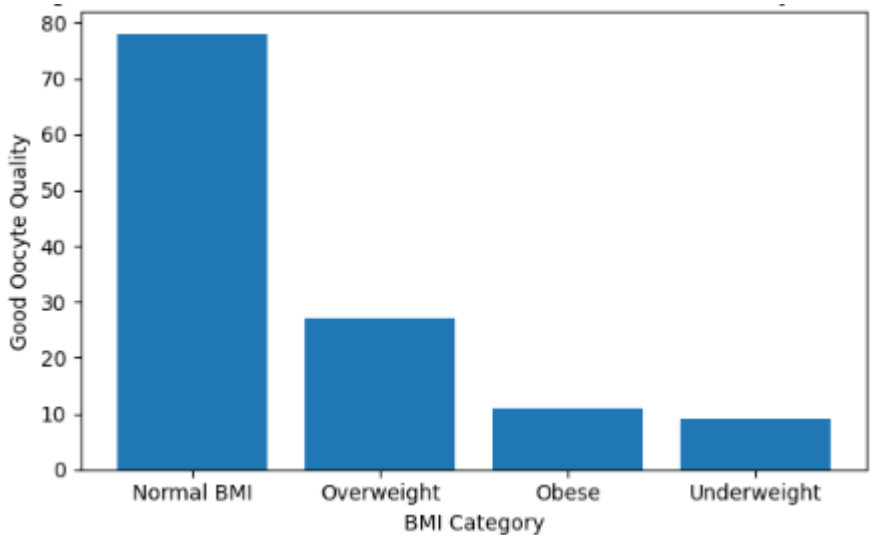

Figure 2: Graphical Representation of Association Between Maternal BMI and Good Oocyte Quality

Figure 2 depicts the relationship between the different BMI classes of mothers and good oocytes. From the illustration, it is evident that the group of mothers who had a normal body mass index

had the highest percentage of good oocytes compared to other groups of overweight, obese, and underweight mothers.

Figure 2 also shows that the quality of oocytes decreases with an increase in the body mass index of mothers. Among the three groups, the obese group had the lowest percentage of good-quality oocytes, indicating the harmful effects of obesity on ovary health and reproduction capability.

3.3 Fertilization and Embryo Development Outcomes

Table 4.3 displays the outcomes of embryo development and fertilisation following intracytoplasmic sperm injection (ICSI) treatment for in vitro fertilisation (IVF) patients. The rates of fertilisation, cleavage, and blastocyst formation are among the important embryological variables considered, as are the total number of oocytes and mature oocytes. Mean ± standard deviation (SD) is how the figures are shown.

Table 3 Fertilization and Embryo Development Outcomes

Variable	Mean ± SD
Retrieved Oocytes	11.8 ± 3.6
Mature Oocytes	8.9 ± 2.8
Fertilization Rate (%)	72.4 ± 10.2
Cleavage Rate (%)	68.7 ± 9.4
Blastocyst Formation Rate (%)	52.6 ± 8.7

The outcomes demonstrated successful fertilisation and embryonic development after in vitro fertilisation (ICSI). The study participants appeared to have a favourable ovarian response, as the average number of eggs collected was 11.8 ± 3.6 and the average number of mature eggs was 8.9 ± 2.8.

The fertilization rate was calculated to be 72.4 ± 10.2%, which implies effective fertilization following ICSI treatment. In a similar manner, the cleavage rate was calculated to be 68.7 ± 9.4%, which implies efficient embryonic development. The blastocyst formation rate was recorded to be 52.6 ± 8.7%.

From these results, it can be concluded that quality eggs have a significant impact on fertilization efficiency, embryonic development, and blastocyst formation during ICSI treatment cycles.

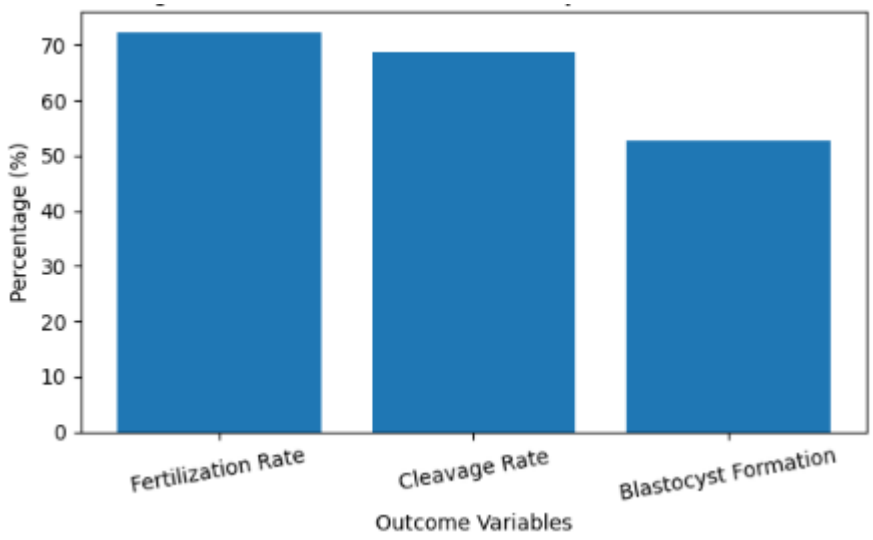

Figure 3: Fertilization and blastocyst Formation Rates

Figure 3 illustrates the trends associated with fertilization, cleavage, and blastocyst formation in individuals undergoing the ICSI procedure. From Figure 3, it is evident that the fertilization rate was the highest compared to other embryological parameters, whereas the blastocyst formation rate ranked third, preceded by the cleavage rate.

The steady decline in the number of embryonic cells from fertilization through cleavage to blastocyst formation highlights the biological phenomenon of embryological selection during embryo growth. In addition, better-quality oocytes have been shown to enhance the developmental ability of embryos and facilitate blastocyst formation.

3.5 Embryo Transfer and Implantation Outcomes

Women who had ICSI-IVF treatment had their embryos transferred and implanted according to the results shown in Table 4. The table compares blastocyst-stage embryo transfer with cleavage-stage embryo transfer in terms of overall patient volume, success rate of implantation, and success rate of pregnancy. We did this to see how well various embryo transfer methods worked.

Table 4 Embryo Transfer and Implantation Outcomes

Embryo Transfer Type	Number of Patients	Implantation Rate (%)	Clinical Pregnancy Rate (%)
Cleavage-Stage Transfer	88	41.2	45.5
Blastocyst Transfer	112	58.9	63.4

Reproductive success was higher with blastocyst stage embryo transfer compared to cleavage stage embryo transfer, according to the study. The clinical pregnancy rate was 63.4% and the implantation rate was 58.9% for 112 patients who had blastocyst embryo transfer.

Embryo transfer at the cleavage stage resulted in a significantly lower implantation rate (41.2%) and a clinical pregnancy rate (45.5%) in the experimental group.

This suggests that embryo transfer at the blastocyst stage ensures greater synchronicity between embryo development and endometrial receptivity.

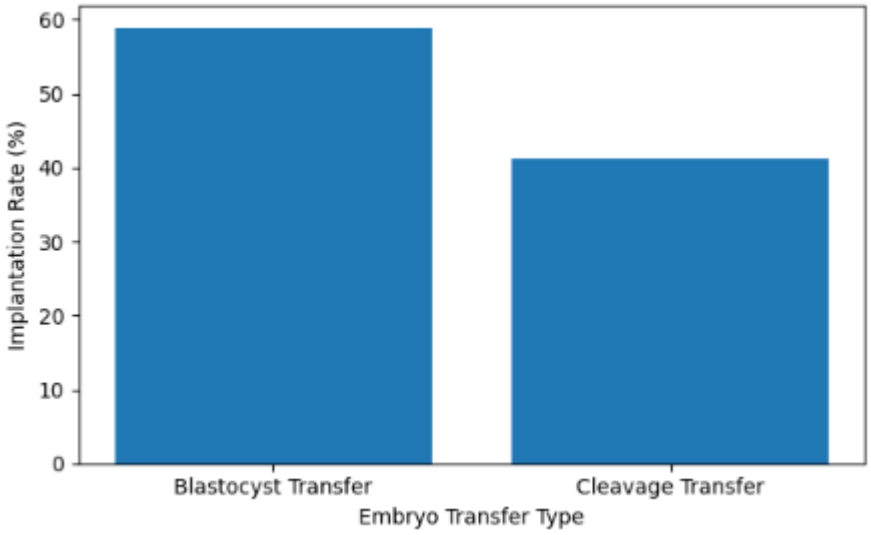

Figure 4: Implantation Rate According to Embryo Transfer Type

The success rates varying by embryo transfer type are illustrated graphically in Figure 4. Embryos implanted during the blastocyst stage had a far higher success rate with implantation than those transferred during the cleavage stage, according to the data supplied here. The data clearly show that blastocyst stage embryo transfer yielded better results in terms of improving embryo implantation. The higher success rate of pregnancies achieved using this procedure is likely to blame for this.

3.6 Live Birth Outcomes According to Maternal BMI

The correlation between the mother's body mass index (BMI) and the number of live births that followed IVF-ICSI procedures is shown in Table 5. Based on different maternal body mass index (BMI) categories, including underweight, normal, overweight, and obese subjects, this table displays the distribution of successful live births and failure births. We calculated the percentage of live births to evaluate the influence of maternal BMI on fertility.

Table 5 Live Birth Outcomes According to BMI Category

BMI Category	Live Birth Achieved	No Live Birth	Live Birth Rate (%)
Underweight	7	11	38.9
Normal BMI	69	27	71.9
Overweight	28	26	51.9
Obese	11	21	34.4

These findings indicated substantial differences in live birth success based on the category of maternal BMI. Maternal individuals with normal BMI had the highest success in live births, with 71.9% of successful live births from 96 study subjects. On the other hand, obese subjects had the lowest live births percentage of 34.4%, which translates into 11 live births from 32 study subjects.

Among those who were overweight, 51.9% of babies were born alive, compared to 38.9% among those who were underweight. The results show that body mass index (BMI) has a detrimental effect on reproductive outcomes and IVF-ICSI success rates.

The findings above suggest that maintaining a normal maternal BMI may result in successful embryo implantation and maintain pregnancies for successful live birth outcomes.

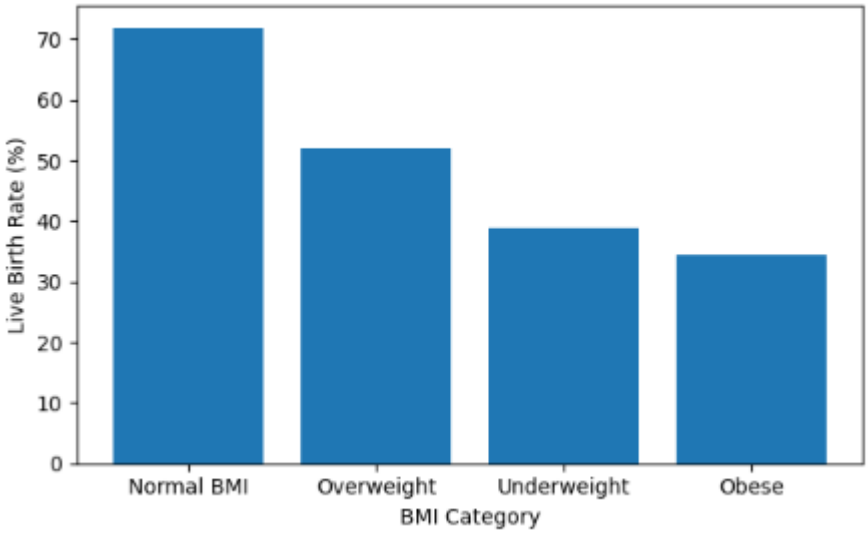

Figure 5: Live Birth Rate

The graph depicted in Figure 5 portrays live birth rates for various maternal BMI classes. It is evident from the graph that women whose BMI is in the normal range had significantly higher live birth success rates than those whose BMI was classified as obese, overweight, or underweight.

The graph also reveals that as maternal BMI rises, the rate of live births reduces especially for obese mothers. The data above highlight the significance of having an appropriate maternal BMI when trying to conceive through assisted reproductive methods.

3.7 Statistical Analysis of Predictors of Live Birth Outcomes

To determine what variables significantly predicted live birth outcomes in women who underwent IVF-ICSI treatment, we ran a logistic regression analysis, and the findings are in Table 4.6. This research looked at the relationship between the mother's BMI, the quality of her eggs and embryos, and the implantation rate and the chance of having healthy babies. For each predictor, we calculated the odds ratios (ORs), 95% CIs, and p-values.

Table 6 Predicting Live Birth Outcomes using Logistic Regression Analysis

Variable	Odds Ratio (OR)	95% Confidence Interval	p-value
Maternal BMI	0.68	0.52 – 0.89	0.004
Oocyte Quality	2.41	1.63 – 3.55	0.001
Embryo Quality	2.86	1.94 – 4.11	0.000
Implantation Success	3.22	2.14 – 4.85	0.000

Results for live births were significantly predicted by maternal body mass index (BMI), oocyte quality, embryo quality, and the success of implantation ($p < 0.05$). A higher maternal body mass index was associated with a lower probability of a healthy delivery, as the odds ratio for this variable was 0.68 (95% CI: 0.52-0.89, $p = 0.004$). The results show that a higher maternal body mass index has a negative effect on the success rate of in vitro fertilisation. Oocyte quality was associated with an odds ratio of 2.41 (95% CI: 1.63-3.55, $p = 0.001$). These results suggest a positive correlation between oocyte quality and live birth outcomes. The odds ratio of 2.86 (95% confidence interval: 1.94-4.11, $p = 0.000$) for live births was also associated with embryo quality. The most important factor was a successful implant, with an odds ratio of 3.22 (95% CI: 2.14-4.85, $p = 0.000$).

4. DISCUSSION

Live birth outcomes for women having in vitro fertilisation were analysed in this study by looking at the effects of ICSI, embryo transfer methods, mother's body mass index (BMI), and egg quality. Pregnancy outcomes were significantly impacted by maternal body mass index (BMI), egg quality, embryo quality, and implantation rate. Higher rates of fertilisation, implantation, and live birth outcomes were associated with women whose body mass index (BMI) was within the normal range.

4.1 Interpretation of Results

Oocyte quality was found to be strongly correlated with maternal BMI, according to the study's findings. Oocyte and embryo formation competence was higher in moms with a normal body mass index compared to those with an overweight or obese status. Low fertilisation, poor blastocyst formation, and fewer live births were seen in mothers with a high body mass index (BMI). It is clear from the foregoing that the mother's reproductive system is negatively affected by metabolic state abnormalities. The results showed that fertilisation and embryo development were positively impacted by high-quality oocytes. Subjects with healthy oocyte morphology had an easier time conceiving and developing blastocysts.

The outcomes of blastocyst embryo transfer showed that compared to cleavage embryo transfer, the rates of implantation and clinical pregnancy were much greater. The higher implantation success rates seen in blastocyst embryo transfer could be due to better coordination between embryo maturity and endometrial receptivity. Factors impacting the success rate of live births following ICSI-IVF treatment encompass the following: mother body mass index (BMI), oocyte

quality, embryo quality, and feasibility of embryo implantation. It became clear that the success of the implantation process was the strongest indicator of a baby being born healthy.

4.2 Comparison with Existing Literature

The following table provides a synopsis of research that has been conducted on several aspects of in vitro fertilisation (IVF) treatments, including maternal body mass index (BMI), embryo quality, fertilisation outcomes, and live birth outcomes. The effect of parental body mass index (BMI), embryonic development, and other reproductive variables on the success rate of assisted reproductive technology (ART) was the focus of these pertinent literature reviews. Such research lends credence to the idea that metabolic factors and embryology play a part in predicting the success or failure of IVF-ICSI.

Table: Review of Literature Related to BMI, ICSI, Embryo Quality, and IVF Outcomes

Author(s) & Year	Title of the Study	Study Focus
L. Kluge et al. (2023) [11]	*Results from nationwide cohort research on the relationship between BMI, live births, and neonatal and maternal outcomes following in vitro fertilisation*	Examined the relationship between maternal BMI and IVF live birth outcomes.
R. Bibi et al. (2022) [12]	*Pregnancy outcomes, sperm chromatin integrity, and fertilisation rates in men undergoing in vitro fertilisation or intracytoplasmic sperm injection at fertility clinics*	Investigated the effect of paternal overweight on sperm quality and IVF/ICSI outcomes.
A. S. Soliman et al. (2018) [13]	*Couples' Embryo Quality and Clinical Outcomes as a Function of Maternal Body Mass Index Fundamentally, ICSI*	Evaluated the relationship between maternal BMI, embryo quality, and ICSI outcomes.
Y. Ren et al. (2025) [14]	*Impact of BMI on pregnancy outcomes following IVF/intracytoplasmic sperm injection in young women with poor prognosis according to POSEIDON criterion*	Assessed the impact of BMI on pregnancy outcomes among low-prognosis IVF/ICSI patients.
Q. C. Cui et al. (2025) [15]	*Looking back at the results of in vitro fertilisation and intracytoplasmic sperm injection in women who were 37 years old or older*	Investigated the effect of BMI on IVF/ICSI embryo transfer outcomes in older women.

It is abundantly obvious from the literature evaluation that BMI is a major factor impacting the success or failure of reproductive therapies. For example, research by L. Kluge et al. (2023) demonstrated that women with a high maternal BMI had a lower chance of having a live birth and worse reproductive health overall following IVF treatment. Consistent with these results, the present investigation found that the success rate of pregnancy was higher for women with a

normal body mass index (BMI) compared to those with an overweight or obese status. Studies conducted by A. S. Soliman et al. (2018) further demonstrate that a high maternal BMI lowers the clinical pregnancy success rate and embryo quality following ICSI treatments.

Regarding this matter, the results of the study conducted by R. Bibi et al. (2022) showed that a father's weight can affect the integrity of his sperm's chromatin and how well they fertilise. The focus of this study is on maternal problems, however both articles highlight how metabolic health affects reproductive outcomes. Studies conducted by Y. Ren et al. (2025) and Q. C. Cui et al. (2025) also indicate that a BMI imbalance can negatively impact IVF-ICSI patients' reproductive efficiency, implantation rates, and pregnancy outcomes.

4.2 Implications of the Study

In order to effectively treat infertility, this study's results stress the need for individualised and patient-centered treatments. The success rates of assisted reproductive technologies (ART) can be greatly enhanced by tailoring treatment plans to each patient's unique characteristics, including their age, hormonal profile, weight, ovarian reserve, and general reproductive health. This study has crucial implications for optimising pregnancy weight, as being overweight or underweight can have unfavourable effects on ovulation, implantation, embryo growth, and pregnancy outcomes. In order to improve reproductive success and decrease pregnancy problems, fertility treatment programs should incorporate dietary counselling, lifestyle adjustment, and metabolic management.

Additionally, the study highlights the need of using sophisticated embryo transfer techniques and conducting complete oocyte quality assessments to enhance reproductive results. Increased implantation and live birth rates with decreased treatment failure rates are possible with modern technologies including blastocyst cultivation, cryopreservation, time-lapse embryo monitoring, and precision-guided embryo transfer. Hormonal profiling, ovarian reserve testing, and reproductive screening all provide extensive evaluations of egg quality, which in turn allows clinicians to develop more effective and personalised treatment programs. Prompt fertility preservation and suitable therapeutic intervention may be possible with early detection of impaired oocyte quality.

To address the physical and emotional obstacles of infertility, the study recommends interdisciplinary infertility care that includes reproductive doctors, embryologists, nutritionists, and psychological counsellors. Greater investment in advanced reproductive technology, public awareness regarding fertility health, additional studies on personalised reproductive medicine, and innovative fertility treatment approaches are all encouraged by the findings, which also have broader implications for healthcare policy and future research.

4.3 Limitations of the Study

- Limited sample size.
- Single-center observational design.
- Possible influence of unmeasured confounding variables.

- Short-term outcome evaluation.

4.4 Suggestions for Future Research

- Large multicenter studies should be conducted.
- Long-term neonatal outcomes should be evaluated.
- Molecular markers of oocyte quality should be investigated.
- Personalized reproductive medicine approaches should be explored.

5. CONCLUSION

Live births in women treated for infertility with in vitro fertilization-ICSI (IVF-ICSI) were the target of this study, which aimed to evaluate the effects of ICSI, embryo transfer methods, maternal BMI, and egg quality. Among women who underwent IVF-ICSI treatment, it was found that embryologic characteristics and maternal BMI were crucial factors in determining reproductive success. A normal body mass index was associated with better egg quality, higher fertilisation rates, better implantation potential, and more live births than an overweight or obese participant. The study also found that embryos transferred at the blastocyst stage had higher rates of implantation and clinical pregnancy than those transferred at the cleavage stage, and that high-quality eggs improved embryo growth, blastocyst development, and implantation rate. The findings highlight the importance of a mother's metabolic health, accurate embryological assessment, and individualised approaches to improving the success rate of IVF-ICSI reproductive treatments. Findings support the hypothesis that healthy lifestyle choices and proper nutrition before in vitro fertilisation (IVF) might keep mothers at an appropriate body mass index (BMI), which in turn increases the likelihood of a successful delivery. Future studies should use larger samples to examine additional lifestyle, genetic, and biological factors that impact IVF-ICSI.

5.1 Summary of Key Findings

This study examined the impact of in vitro fertilisation (IVF), embryo transfer techniques, maternal body mass index (BMI), and egg quality on the success rate of live births. Mothers' body mass index (BMI) has a significant impact on reproductive health; those with a normal BMI had better eggs, a higher rate of fertilisation, a smoother implantation process, and more live births than those with an obese or overweight BMI.

The success rate of fertilisation, cleavage, blastocyst formation, and implantation was higher when using high-quality oocytes. When comparing implantation and clinical pregnancy rates, embryos transferred at the blastocyst stage performed better than those transferred at the cleavage stage. The following factors were identified as drivers of live birth outcomes using logistic regression models: mother BMI, oocyte quality, embryo quality, and implantation success.

5.2 Significance of the Study

This study is very important since it reveals how crucial it is for mothers' metabolic status and embryos' quality in the prediction of IVF pregnancy success. Thus, this study adds to the existing body of knowledge related to reproductive health science since it helps reveal some aspects of relationship between maternal BMI, oocyte competence, embryo quality, and fertility efficiency.

Another important aspect of the discussed research relates to the necessity of implementing personalized programs for infertility treatment along with the utilization of embryo transfer protocol optimization and accurate assessment of the embryonic development process.

5.3 Final Thoughts and Recommendations

According to the results, the researchers recommend that women intending to undergo assisted conception treatment maintain a healthy weight and change their lifestyles for better reproductive results. For fertility centers, it is recommended that preconception nutritional education, weight management, and metabolic testing be considered before assisted conception.

The study also suggests that careful assessment of the quality of oocytes and embryos is required during IVF-ICSI procedures to increase the chances of embryo selection and successful implantation. Transfer of blastocyst-stage embryos might be considered in patients where appropriate.

More study on other biological and genetic parameters affecting IVF success should be conducted. With advances in the field of assisted reproduction technology and personalized approaches to infertility treatments, the possibility of improving pregnancy outcomes can be explored.

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