



**Evaluating The Clinical Efficacy Of Preimplantation Genetic Screening In
Optimizing Ivf Success Rates Under Variable Biological Conditions**

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ABSTRACT

Infertility is currently becoming a major health issue in the world with many couples turning to the use of assisted reproductive technologies including In Vitro Fertilization (IVF); the success rates of IVF are however fluctuating as a result of various factors including maternal age, embryo quality and failed attempts of IVF. This paper will assess the clinical effectiveness of Preimplantation Genetic Screening (PGS) in the optimization of IVF outcomes in varying biological settings with the help of a quantitative and comparative research design relying on secondary clinical data. The patients were divided into PGS and non-PGS groups, and the main reproductive outcomes were compared with statistical comparisons on the basis of percentage, such as the implantation rate, clinical pregnancy rate, live birth rate and miscarriage rate. The findings indicate that IVF cycles with PGS have a significantly better implantation rate (68%), clinical pregnancy rate (62%), and live birth rate (58%) and a significantly low miscarriage rate (12%). Moreover, in spite of the decreasing success rates with maternal age and repeated IVF failures, the use of PGS will always improve the results in all categories of cases, as it will enable us to select chromosomally normal (euploid) embryos. Another critical point that the study brings to light is that the quality of embryos is still an essential factor, but genetic screening increases the probability of success even in moderate and poor-quality embryos. The results in general indicate that PGS is a very useful instrument that can be used in enhancing IVF rates, minimizing reproductive risks, and facilitating individualized and evidence-based reproductive treatment plans, especially in cases of high-risk and repeat failures.

Keywords: Preimplantation Genetic Screening, In Vitro Fertilization, IVF Success Rate, Embryo Quality, Maternal Age, Reproductive Outcomes.

1. INTRODUCTION

Infertility has emerged as a widespread health problem in the world, and the problem has been experienced by millions of couples globally, which is a great source of emotional, psychological, and financial problems. Assisted Reproductive Technologies (ART) and In Vitro fertilization (IVF) in particular have transformed the treatment of infertility providing hope to couples who cannot get pregnant naturally. Nonetheless, although there is a technological development, IVF success rates are still erratic and depend on various biological and clinical variables including maternal age, embryo quality, ovarian reserve, hormonal abnormalities, and previous reproductive history. Another significant weakness of traditional IVF is the lack of reliability in the use of morphological analysis to determine genetically

normal embryos. Aneuploidy or the presence of chromosomal abnormalities in embryos is a major cause of failure to implant, recurring pregnancy loss, and low rates of live birth particularly in women of advanced maternal age. There has been an increased use of Preimplantation Genetic Screening (PGS) which is a method that enables the genetic screening of embryos before transfer, a practice that enhances the selection of viable embryos.

In this regard, this research has the goal of assessing the clinical effectiveness of PGS to maximize the success rate of IVF in fluctuating biological circumstances. The article focuses on the comparative evaluation of the IVF cycles with PGS and without it, as well as the effect of the most critical variables, including maternal age, embryo quality, and previous IVF failures, on the outcomes of the treatment. Through genetic screening in combination with conventional IVF procedures, PGS can be used to improve the success rates of implantation, clinical pregnancy, and live birth, as well as greatly lower the incidence of miscarriage. In addition, its relevance is especially high in high-risk populations, such as older women and those who have undergone several unsuccessful IVF procedures, as the chance of chromosomal abnormalities increases in these cases. This study aims to make a contribution towards the development of personalized reproductive medicine by offering a better insight into the application of PGS to enhance clinical decision-making and maximize reproductive success in a variety of patients.

2. LITERATURE REVIEW

Brown (2025) studied new ways of doing the In Vitro Fertilization (IVF) procedures with a focus on combining the use of genomic screening and tailored treatment plans to boost reproductive success. The paper noted that conventional IVF procedures were generally limited because of the biological variation of patients and as such, the use of advanced genetic screening technologies including Preimplantation Genetic Screening (PGS) was an effective means of enhancing embryo selection. It was discovered that individualized treatment regimens with genetic guidance led to increased rates of implantation, live birth, and decreased exposure to the risk of miscarriage. The article highlighted the increasing role of precision medicine in reproductive health.

Capalbo et al. (2021) examined the clinical validity and utility of preconception expanded carrier screening in the management of reproductive genetic risks both in IVF patients and in the general population. The researchers indicated that genetic prenatal screening before conception was important in determining possible hereditary disorders, hence making informed choices in assisted reproduction. According to their findings, the combination of carrier screening and IVF procedures would result in better clinical outcomes as the transfer of the embryo with genetic abnormalities would be minimized. The paper also showed that this screening mechanism enhanced general reproductive planning and lowered prevalence of genetic illnesses.

Dehghan et al. (2024) undertook comparative research on the use of machine learning methods coupled with genetic algorithm to forecast IVF success rates. The researchers concluded that high level of computational models highly enhanced the accuracy of predicting the outcome of treatments in the process of examining numerous clinical and biological variables. The findings

showed that machine learning with genetic data gave a better predictive model than the conventional statistical analysis. The method assisted in streamlining treatment plans and enhancing decision-making at the patient level, which contributes to increased success rates of IVF interventions.

Doroftei et al. (2022) conducted a mini-review to evaluate the clinical outcomes of In Vitro Fertilization (IVF) following the use of Preimplantation Genetic Testing (PGT) with Next Generation Sequencing (NGS). The researchers indicated that the combination of high-technology genomic techniques greatly enhanced the embryo selection through the proper identification of chromosomal abnormalities. The results revealed that PGT-NGS use improved the implantation rate, clinical pregnancy and live birth rates, and decreased the risks of miscarriage. The authors discussed that genetic testing using NGS was a significant breakthrough in reproductive medicine that provided more accurate and reliable results as opposed to traditional methods.

Du et al. (2023) examined some of the existing preimplantation genetic testing technologies and their uses in assisted reproduction. The paper has shown how genetic screening processes have evolved, with such techniques as array comparative genomic hybridization (aCGH), quantitative PCR, and Next Generation Sequencing (NGS). The authors discovered that these technologies had enhanced the accuracy and efficiency of identifying genetic abnormalities in embryos, which in turn helped in enhancing better IVF outcomes. The review highlighted that PGT was highly important in the mitigation of hereditary genetic disorders and improvement of reproductive success especially in high-risk populations.

3. RESEARCH METHODOLOGY

The research design is quantitative and comparative, relying on secondary clinical data on IVF patients (PGS and non-PGS). Improved purposive sampling was applied in the analysis of key results such as implantation, pregnancy, live birth and miscarriage rates with respect to maternal age, embryo quality and past failures with the statistical comparison being done through percentages.

3.1 Research Design

The current research design is qualitative and comparative research to assess the clinical effectiveness of Preimplantation Genetic Screening (PGS) to enhance the success rates of IVF. The results of the study compare the results of the IVF cycles done with PGS and without it under several biological conditions like maternal age, embryo quality and previous IVF failure.

3.2 Study Population and Sample Size

The targeted population involves women undergoing IVF in selected fertility clinics. The total sample of patients undergoing IVF cycles was taken into consideration and divided into two groups, namely those who were treated with PGS and those who were not. The sample also involves subgroups on the basis of maternal age, embryo quality and history of past IVF failures.

3.3 Sampling Technique

Purposive sampling was employed to include the patients that were subjected to IVF treatment and had all the clinical data. The grouping of patients was done on the basis of some of the biological variables to compare the results.

3.4 Data Collection Method

The study is based on secondary data collected from clinical records and IVF reports. Key outcome measures incorporated in the data were the implantation rate, clinical pregnancy rate, live birth rate, and the miscarriage rate. The other variables that were also noted to be analyzed in detail included maternal age, embryo quality and the number of prior IVF failures.

3.5 Variables of the Study

- **Independent Variable:**
 - Preimplantation Genetic Screening (PGS) (With PGS / Without PGS)
- **Dependent Variables:**
 - Implantation Rate
 - Clinical Pregnancy Rate
 - Live Birth Rate
 - Miscarriage Rate
- **Control Variables:**
 - Maternal Age
 - Embryo Quality
 - Previous IVF Failures

3.6 Data Analysis Techniques

The collected data were analyzed using descriptive statistical methods, primarily percentages and comparative analysis. Comparison of IVF outcomes among groups was done in terms of tables and graphical representations. The findings were put into interpretation to determine trends and relationships between PGS and IVF successes in various biological conditions.

4. RESULT AND DISCUSSION

The findings indicate that the IVF success declines with the number of previous failures, but PGS use enhances the live birth rates in all categories. This implies that PGS can be used to determine the potential viability of embryos and it is particularly useful in patients with recurrent IVF failure.

4.1 IVF Outcomes with and without PGS

Table 1 and Figure 1 provide a comparative study of IVF results of cycles done with Preimplantation Genetic Screening (PGS) and without it. The statistics have shown that the implantation rate (68%), clinical pregnancy rate (62%), and live birth rate (58%) have significantly increased in the PGS group as compared to the non-PGS group that stood at 45, 40, and 35% respectively. On the other hand, the miscarriage rate of PGS group (12) is significantly low as opposed to that of non-PGS group (28).

Table 1: Comparison of IVF Outcomes (With vs Without PGS)

Outcome Measure	With PGS (%)	Without PGS (%)
Implantation Rate	68%	45%
Clinical Pregnancy Rate	62%	40%
Live Birth Rate	58%	35%
Miscarriage Rate	12%	28%

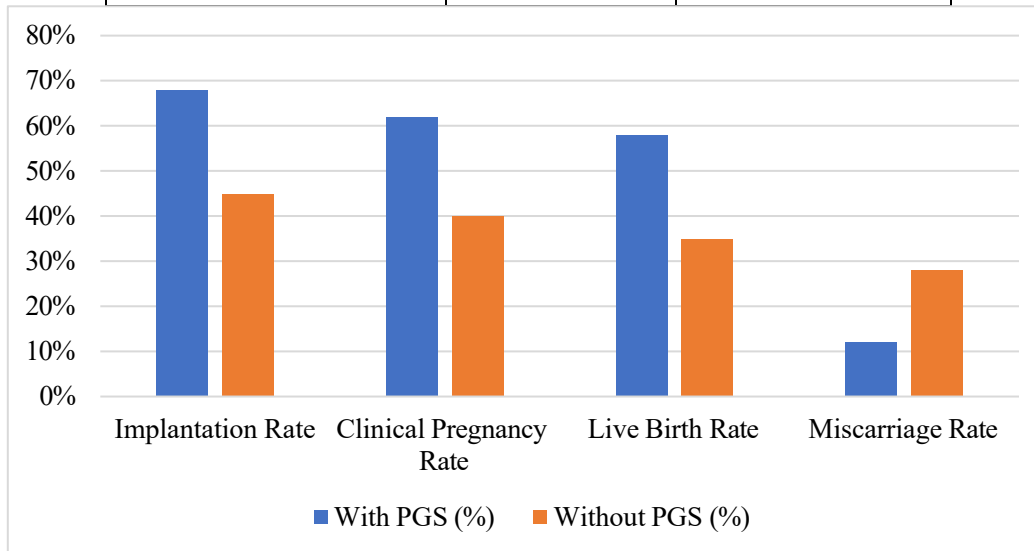


Figure 1: Graphical Representation of Comparison of IVF Outcomes (With vs Without PGS) The results indicate with clarity that application of PGS can greatly increase the success rate of IVFs and decrease the chances of miscarriage. This is possible because the genetically normal (euploid) embryos are selected which enhances the implantation chances and reduces the number of pregnancy losses. Thus, PGS seems to be a clinical tool that is effective in maximizing the reproductive outcomes, especially those patients with increased risk of having chromosomal abnormalities.

4.2 Influence of Maternal Age on PGS Effectiveness

Table 2 and Figure 2 depict that the success rate of IVF with PGS varies with the maternal age. Women under 30 years have the highest implantation rate (72%), live birth rate (65%). These rates steadily decrease as age advances, with women of 30-35 years of age having implantation and live birth rates of 68 and 60, respectively. Another reduction is in the 36-40 age brackets (60% and 52%), but women above 40 years have the lowest implantation and live birth rates (48% and 40% respectively).

Table 2: IVF Success Rates by Maternal Age Group (With PGS)

Age Group (Years)	Implantation Rate (%)	Live Birth Rate (%)
< 30	72%	65%
30–35	68%	60%
36–40	60%	52%
> 40	48%	40%

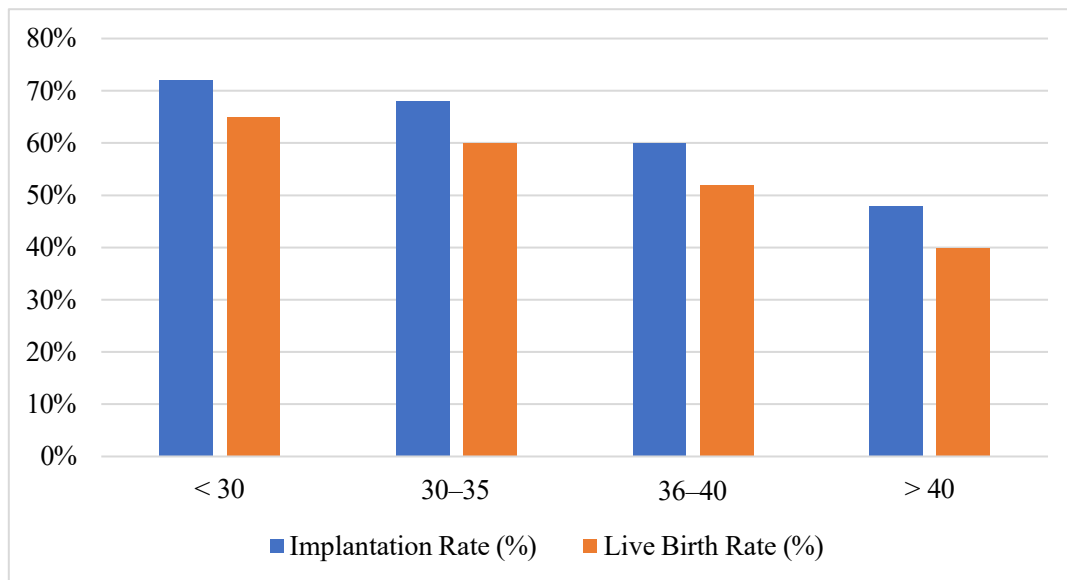


Figure 2: Graphical Representation of IVF Success Rates by Maternal Age Group (With PGS) The findings suggest that PGS can improve the IVF outcomes regardless of all age groups; however, maternal age is a decisive factor of success. The current decreasing pattern indicates the natural decreasing ovarian reserve and augmented chromosomal abnormalities with age. The success rates that have been relatively preserved in older age groups, though, indicate that PGS can alleviate the age-related reproductive difficulties by allowing to select genetically viable embryos.

4.3 Impact of Embryo Quality on IVF Outcomes

The results of IVF with PGS in the various types of embryos are shown in Table 3 and Figure 3. Embryos of high quality have the greatest implantation rate (75%), and the highest clinical pregnancy rate (70%). Embryos of moderate quality have slightly lesser yet good results, implantation and pregnancy rates of 62% and 58, respectively. Embryos of poor quality have the lowest success rate (implantation and clinical pregnancy rates of 45 and 40 %, respectively)..

Table 3: IVF Outcomes Based on Embryo Quality (With PGS)

Embryo Quality	Implantation Rate (%)	Clinical Pregnancy Rate (%)
High Quality	75%	70%
Moderate	62%	58%
Poor	45%	40%

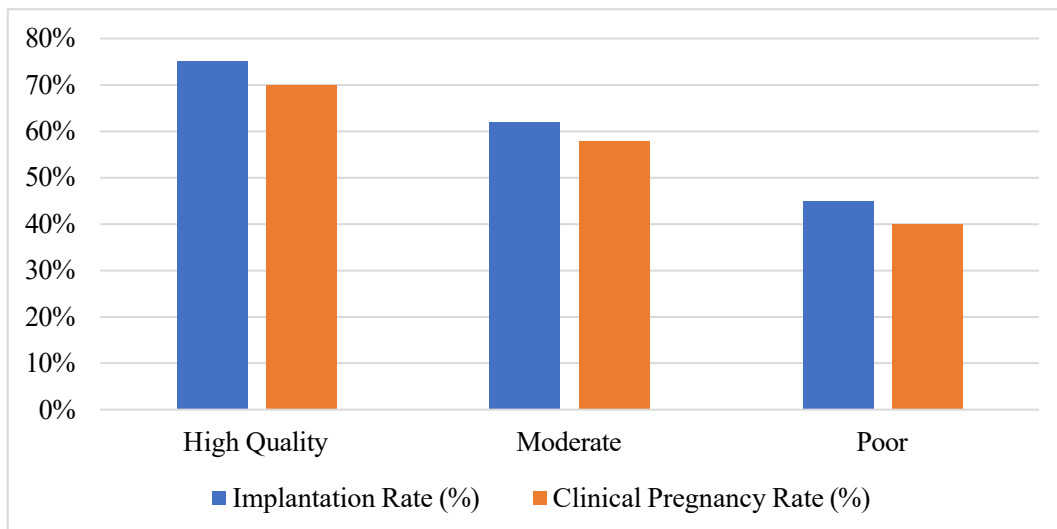


Figure 3: Graphical Representation of IVF Outcomes Based on Embryo Quality (With PGS)
The findings show that even the use of PGS, embryo quality continues to play an important role in determining the success of IVF. Nevertheless, the moderate and poor-quality embryo that are relatively successful indicates that genetic screening improves selection of embryos with normal chromosomes that could not have been selected purely on morphological grounds. This underscores the fact that morphology is a crucial factor but genetic competence is very critical in the determination of reproductive outcomes.

4.4 Effect of Previous IVF Failures

Table 4 and Figure 4 provide a comparison of live birth rates between patients who have different number of prior IVF failures with and without use of PGS. In patients who have already had 1-2 previous failures, the live birth rate is 55 % in patients undergoing PGS versus 38 % in those patients not undergoing PGS. The rates are 50 % with PGS and 30 % without in cases of 3-4 failures. The success rate of patients who have failed more than four times is reduced to 45 and 25 % in PGS and no PGS, respectively. All in all, there is a downwards trend in the success rates with the increase in the number of past failures.

Table 4: IVF Success in Patients with Previous Failures

Number of Previous Failures	Live Birth Rate with PGS (%)	Live Birth Rate without PGS (%)
1-2 Failures	55%	38%
3-4 Failures	50%	30%
>4 Failures	45%	25%

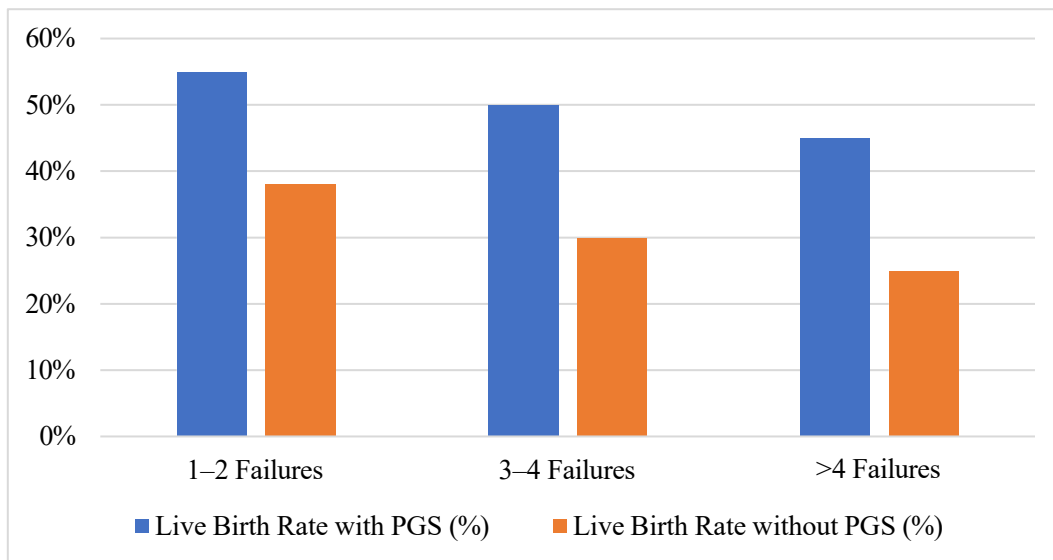


Figure 4: Graphical Representation of IVF Success in Patients with Previous Failures

The results indicate that repeated IVF failures are associated with adverse effects on overall success rates, whereas the application of PGS has a positive effect on live births in all populations. This means that the unnoticed chromosomal abnormalities could be a leading cause of repeated failures and PGS can solve this problem as it allows selection of viable embryos. Thus, PGS may be viewed as an effective intervention of patients who experienced multiple IVF failures.

4.5 Discussion

The study results clearly indicate that Preimplantation Genetic Screening (PGS) has a major impact in enhancing IVF outcomes in various biological conditions. The increase in the rate of implantation, clinical pregnancy rate and live birth rate and a decrease in the rate of miscarriage suggests that the reproductive success is promoted through the selection of chromosomally normal embryos. Moreover, maternal age and embryo quality are also factors that affect the results, but PGS allows achieving rather high success rates even in the case of older women and in moderate-quality embryos, which demonstrates its clinical efficiency.

Moreover, the research indicates that PGS helps patients with multiple IVF failures especially since it has continued to raise the live birth rates as opposed to the traditional methods. Although the success rate reduces with an increase in failures recorded, the use of PGS assists in overcoming genetic problems which could be the cause of failure cycles. On the whole, these results indicate that even though biological factors cannot be fully removed, PGS is a useful instrument in maximizing the success of IVF and enhancing patient outcomes.

5. CONCLUSION

The current research evidently proves that Preimplantation Genetic Screening (PGS) is a very effective and valid clinical intervention in enhancing success rates in IVF among various biological diseases. The results have shown that PGS has a significant positive impact on implantation, clinical pregnancy rates, and live birth rates and a significant negative impact on miscarriage rates compared to the traditional IVF procedures. Whilst the maternal age, the quality of embryos, and the history of past IVF failures remain the critical biological parameters

that denote the reproductive success of the intervention, the implementation of PGS helps to overcome these drawbacks by allowing the proper selection of chromosomally normal (euploid) embryos. The study also points out that in difficult situations, like old age of the mother and repeated IVF failure, PGS has always shown better results hence higher chances of positive pregnancies. Also, the fact that PGS can enhance the success rates of moderate and poor-quality embryos highlights its significance in addition to the conventional morphological evaluation. In general, the findings emphasize the increasing importance of genetic screening in the area of assisted reproduction and justify its role in promoting customized and evidence-based fertility interventions, which eventually improve patient outcomes and clinical decision-making.

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