Pregnancy Outcome After Transferring Genetically Tested Embryos vs. Non-Tested Embryos

Charkviani T.[1,2], Kristesashvili J.[1], Zhorzholadze T.[2], Kutchukhidze N.[2], Barbakadze T.[2], Gabadze M.[2], Kbilashvili T.[2], Makharadze M.[3]

Abstract

Background: Assisted reproductive technology (ART) has revolutionized fertility treatments, offering many couples a chance at pregnancy who might otherwise have difficulty conceiving. One of the critical factors for ART success is the selection of viable embryos for transfer. Preimplantation genetic testing for aneuploidy (PGT-A) has emerged as a widely used method to enhance embryo selection, improve pregnancy outcomes, and reduce the risk of miscarriage. (2). By identifying chromosomally normal (euploid) embryos, PGT-A aims to increase implantation rates and overall IVF efficiency (3).
Aim: This article aims to provide a comprehensive comparison of pregnancy outcomes between genetically tested (PGT-A) and non-tested embryos. Specifically, it examines implantation rates, miscarriage rates, live birth rates, and time to pregnancy, we seek to determine the clinical value of PGT-A and its role in optimizing ART outcomes.
Design: Retrospective, comparative study.
Materials and methods: A total of 225 patients were included in this study, all of whom were under the age of 35. The study population included recipients, advanced maternal age patients, as well as patients with a history of recurrent miscarriages. All donors and young patients underwent ovarian stimulation with GnRH-antagonist protocol, The ovulation trigger was administered when 20% of follicles reached 18 mm. Aspiration was performed 35 hours after the ovulation trigger was administered followed embryo transfer as part of their IVF treatment. The resulting blastocysts underwent preimplantation genetic testing for aneuploidy (PGT-A) using next-generation sequencing (NGS). Pregnancy outcomes were assessed by biochemical indicators, miscarriages, and live births. The patients were divided into two groups - PGT-A Group (First Group): 110 patients who underwent preimplantation genetic testing for aneuploidy (PGT-A). Non-PGT-A Group (Second Group): 115 patients who did not undergo genetic testing of embryos.
Results: A total of 116 embryos were transferred in the PGT-A group, single embryos were transferred to 104 patient and six patients requesting the transfer of two blastocysts. In this group, 59 pregnancies were achieved (53.6%). Among them, 4 pregnancies resulted in miscarriage at 6–7 weeks of gestation (6.8%), and 2 were biochemical pregnancies (3.4%), where pregnancy was detected only by hCG levels in the blood. Ultimately, 53 pregnancies continued to delivery (89.8% of pregnancies, 48.2% of all transfers), with live births occurring between 38 and 40 weeks of gestation. In the non-PGT-A group, 220 embryos were transferred, with an average of 1.91 embryos per patient, leading to 41 pregnancies (35.7%). In this group, 7 pregnancies miscarried at 6 weeks (17.1%), 2 patients experienced late miscarriage at 14–16 weeks (4.9%), and one fetus out of them (2.4%) was diagnosed with a chromosomal abnormality. The remaining 32 patients delivered healthy babies at 37–40 weeks of gestation (78% of pregnancies, 27.8% of all transfers).
Conclusion: PGT-A offers a significant advantage by selecting euploid embryos in improving pregnancy outcomes and reducing miscarriage rates(3). However, its routine use should be tailored to patient-specific factors. Further large-scale studies are needed to optimize patient selection criteria for PGT-A, ensuring its application is both cost-effective and beneficial for intended parents(4). **(TCM-GMJ August 2025; 10 (2): P7-P12)**

Keywords: Preimplantation Genetic Testing (PGT), Next-generation Sequencing (NGS), in Vitro Fertilization (IVF), Implantation Rate, Miscarriage Rate, Live Birth rate, Chromosomal Abnormalities, Assisted Reproductive Technology (ART).

Introduction

Assisted reproductive technologies (ARTs) have become cornerstone in modern reproductive health care, offering solutions to many women and couples facing fertility challenges. As the field continues to evolve, enhancing the effectiveness of ARTs remains a priority. The success of ART treatments is influenced by various factors, including egg quality associated with the woman's age [5] [6], the protocols of controlled ovarian stimulation (COS) [7] [8], the type of ovulation trigger administered for final oocyte maturation, blastocyst quality and ploidy [9] [10], endometrial condition, and overall health. Moreover, synchronization between the endometrium and embryo is critical during implantation to maximize the chances of a successful pregnancy.

One significant advancement in ART is the develop-

From the [1]Ivane Javakhishvili Tbilisi State University, Tbilisi, Georgia; [2]Georgian-American Center for Reproductive Medicine "ReproART," Tbilisi, Georgia; [3]Undergraduate from David Tvildiani Medical University, Tbilisi, Georgia.
Received July 1, 2025; accepted July 20 , 2025.
Address requests to: Charkviani Tea
E-mail: teacharkviani71@gmail.com
Copyright © 2025 Translational and Clinical Medicine-Georgian Medical Journal

ment of preimplantation genetic testing (PGT), which has revolutionized in vitro fertilization (IVF). By enabling the identification of chromosomally normal embryos before transfer, PGT reduces the risk of implantation failure and miscarriage, thus improving pregnancy outcomes [11].

Among the various forms of PGT, preimplantation genetic testing for aneuploidy (PGT-A) has become widely utilized to enhance embryo selection (1). Preimplantation genetic testing for aneuploidy (PGT-A) has become a widely used method to enhance embryo selection, improve pregnancy outcomes, and reduce the risk of miscarriage. PGT-A aims to identify embryos with the correct chromosomal complement (euploid embryos) and avoid transferring aneuploid embryos, which are more likely to result in failed implantation or miscarriage [2]. The primary goal of PGT-A is to increase implantation rates by ensuring that only euploid embryos are transferred, thereby improving the efficiency of IVF cycles[3].

Historically, embryo selection was based solely on morphological assessment, a method that, while useful, has limitations in detecting chromosomal abnormalities that could negatively impact pregnancy viability [12]. The introduction of genetic screening techniques such as fluorescence in situ hybridization (FISH), array comparative genomic hybridization (aCGH), and next-generation sequencing (NGS) has significantly improved the accuracy of embryo assessment [4]. These technologies allow for a more precise distinction between euploid, aneuploid, and mosaic embryos, thereby refining the embryo selection process [13].

Despite the clear advantages of PGT-A in reducing implantation failure and pregnancy loss, the routine use of this technology remains a subject of debate [14]. Critics argue that PGT-A may not always improve cumulative live birth rates, especially in younger women with a good ovarian reserve, as some aneuploid embryos have been shown to self-correct after implantation [15]. Additionally, the cost of PGT-A adds a financial burden to an already expensive IVF process, raising questions about its cost-effectiveness [2].

This article aims to provide a comprehensive comparison of pregnancy outcomes between genetically tested and non-tested embryos by examining key factors such as implantation rates, miscarriage rates, live birth rates, and time to pregnancy for determine the clinical value of PGT -A and its role in optimizing ART outcomes [11].

Methods

Study Design and Participants:

This retrospective study was conducted at the Georgian-American Center for Reproductive Medicine, ReproART, from January 2019 to March 2021. A total of 225 patients were included in this study, all of whom were under the age of 35. The study population also included egg donors for advanced maternal age patients as well as younger patients with a history of multiple miscarriages.

Inclusion and Exclusion Criteria:

Patients were selected based on standardized criteria. The inclusion criteria are presented in table 1.

Exclusion criteria included:

- Irregular menstrual cycles
- Abnormal BMI
- Polycystic ovary syndrome (PCOS)
- Sexually transmitted diseases
- Complicated obstetric history
- Endometriosis
- Uterine abnormalities
- Previous ovarian surgeries
- Male factor infertility

Ovarian Stimulation Protocol

All participants underwent ovarian stimulation using a GnRH-antagonist protocol with prior ovarian downregulation via oral contraceptives to synchronize donor and recipient cycles. Stimulation was initiated on the fifth day after discontinuing oral contraceptives using: Recombinant FSH (Gonal-F, Merck Serono, Germany) with combination with Highly purified human menopausal gonadotropin (h-hMG, Menopur, Ferring Pharmaceuticals, Switzerland).

The initial gonadotropin dose was 450 IU FSH for the first two days, followed by dose adjustments based on ultrasound monitoring and hormonal evaluations (FSH, LH, E2). The average stimulation duration was 11–12 days. – ovarian stimulation parameters are described in table 2

When at least one follicle reached 14 mm in diameter, Cetrotide 0.25 mg (Merck Serono, Germany) was administered. Ovulation triggering included: 10,000 IU hCG (Pregnyl, Organon, Netherlands) or 1,500 IU hCG + GnRH-agonist (Decapeptyl 0.2 mg, Ferring Pharmaceuticals, Switzerland) or GnRH-agonist alone (Decapeptyl 0.2 mg) for patients with >25 follicles

Oocyte Retrieval and Fertilization

Oocyte retrieval was performed 35 hours after ovulation trigger using transvaginal ultrasound-guided aspiration (17-gauge needles, Gynetics-Fertitech, Belgium) at 120 mmHg aspiration pressure under IV anesthesia.

All retrieved oocytes underwent ICSI, and fertilization assessment was conducted 16-18 hours post-ICSI.

Embryo Culture and PGT-A Testing

Embryos were cultured using Quinn's Advantage media (Origio, Netherlands). Blastocyst formation was assessed on days 5, 6, and 7 using Gardner's grading method [16] Trophectoderm biopsy was performed for PGT-A testing at Reprogenetics/Cooper Genomics (New Jersey, USA, or UK) using NGS technology.

Embryo Transfer and Endometrial Preparation:

Endometrial preparation for embryo transfer involved 9 mg estradiol daily, with additional GnRH-agonist suppression for surrogate mothers. Progesterone (Luteina 200 mg vaginally, Prolutex 25 mg intramuscularly) was initiated when endometrial thickness exceeded 8 mm.

Retrospective Analysis:

A retrospective analysis was conducted comparing pregnancy outcomes between PGT-A tested and non-tested embryos.

Analytical Approach and Statistical Methods:

All statistical analyses and visualizations in this presenta-

tion were performed using T-test, ANOVA, Python to determine the significance of differences between groups

Results and discussion

A total of 225 patients underwent frozen embryo transfer (FET) and were divided into two groups: First group - PGT-A group included 110 patients and second group - Non-PGT-A group with 115 patients

A total of 116 embryos were transferred in the PGT-A group, single embryos were transferred to 104 patient and six patients requesting the transfer of two blastocysts. This resulted in 59 pregnancies (53.6%), of which: 4 pregnancies miscarried at 6–7 weeks of gestation (6.8%); 2 biochemical pregnancies (3.4%); 53 pregnancies continued to delivery (89.8% of pregnancies, 48.2% of all transfers), with live births occurring at 38-40 weeks of gestation.

In the non-PGT-A group, 220 embryos were transferred (1.91 embryos per patient), leading to 41 pregnancies (35.7%), of which: 7 pregnancies miscarried at 6 weeks (17.1%); 2 patients experienced late miscarriage at 14–16 weeks (4.9%); 1 fetus out of those two (2.4%) was diagnosed with a chromosomal abnormality; 32 patients delivered healthy babies at 37–40 weeks of gestation (78% of pregnancies, 27.8% of all transfers) the comparison of pregnancy outcomes seen in figure 1

To rigorously test whether the difference in pregnancy rates between the PGT and non-PGT groups is statistically significant, accounting for the number of patients in each group. The logistic regression analysis (Figure 2) revealed a statistically significant difference between the PGT and non-PGT groups ($p < 0.001$). The Z-value (-2.18) confirmed the distinct outcomes in the PGT group after adjusting for group size. The ROC curve demonstrated the model's strong predictive accuracy, with an AUC of 0.90, highlighting its effectiveness in distinguishing between the two groups regarding pregnancy outcomes.

The findings of this study support the efficacy of PGT-A in improving pregnancy outcomes by increasing implantation rates, reducing miscarriage rates, and optimizing embryo selection. The pregnancy rate in the PGT-A group (53.6%)was significantly higher than in the non-PGT-A group (35.7%), demonstrating the advantage of selecting euploid embryos. Furthermore, the miscarriage rate was lower in the PGT-A group (6.8%) compared to the non-PGT-A group (17.1%), emphasizing the role of genetic testing in reducing early pregnancy losses. Numerous studies have compared the efficacy of PGT-A with non-PGT-A embryo transfers, with mixed results depending on the patient population and study design. PGT-A is consistently associated with higher implantation and clinical pregnancy rates, particularly in older women and those with recurrent pregnancy loss. For instance, clinical pregnancy rates after PGT-A have been reported to reach approximately 60% significantly higher than non-PGT-A transfers (17) Similarly, Scott et al. demonstrated that PGT-A cycles resulted in an implantation rate of ~65%, further highlighting the technique's potential to improve pregnancy outcomes in select populations.

One of the key advantages of PGT-A is its ability to reduce miscarriage rates by selecting euploid embryos, which have a lower likelihood of resulting in early pregnancy loss. Studies such as Dahdouh et al. found that miscarriage rates after PGT-A were significantly lower, often below 10%, compared to non-PGT-A transfers [18]

However, despite these advantages, the universal application of PGT-A remains controversial. Some studies, such as Mastenbroek et al., found no significant difference in live birth rates between PGT-A and non-PGT-A groups in younger women, raising concerns about the necessity of genetic testing in patients with a good prognosis [19] These findings suggest that PGT-A should be applied selectively rather than routinely, particularly in younger patients with high-quality embryos.

In addition to these clinical considerations, the cost-effectiveness of PGT-A has become an important factor in evaluating its broader application in IVF treatments. While the total cost of an IVF cycle that includes PGT-A is higher than a conventional IVF cycle without genetic testing, the cost-effectiveness of PGT-A becomes evident when considering long-term outcomes. Transferring non-PGT-A embryos is associated with lower implantation rates, higher miscarriage risks, and increased emotional and financial burdens on patients.[20]

Patients undergoing IVF without genetic testing may require multiple embryo transfers due to failed implantations, ultimately leading to increased expenses over time. Studies have shown that for certain age groups, PGT-A can reduce the average cost per infant,making it a cost-effective strategy in specific populations [21]

Failed implantation and miscarriage result in psychological distress and emotional strain, prolonging the journey to parenthood. Research indicates that infertility and repeated IVF failures can lead to increased rates of depression and anxiety among patients [22] The physical and psychological stress of repeated miscarriages can also place couples at risk of relationship strain.Recurrent pregnancy loss has been associated with significant psychological distress for both partners, potentially leading to symptoms of depression, anxiety, and lowered self-esteem. Additionally, the emotional toll of recurrent miscarriages can negatively impact couple relationships and sexual intimacy.[23]

In cases where a non-PGT-A embryo results in pregnancy but later leads to miscarriage, medical interventions such as dilation and curettage (D&C) may be necessary, which can pose risks to the patient's reproductive health and reduce future pregnancy success rates. For instance, a study published in Human Reproduction found that a history of curettage is associated with an increased risk of preterm birth in subsequent pregnancies. However, other research indicates that D&C does not significantly affect future pregnancy outcomes.[24]

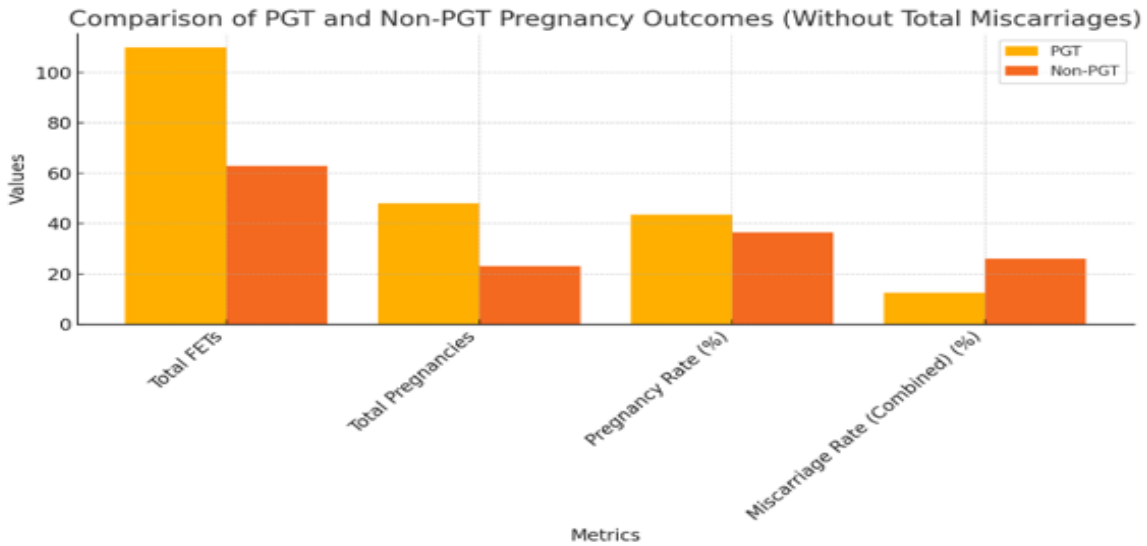
Overall, this study supports the use of PGT-A as an effective tool for improving pregnancy outcomes, particularly in women at risk of implantation failure or miscarriage. However, its clinical application should be tailored based on individual patient characteristics, ovarian reserve, and clinical history to maximize the chances of a successful pregnancy. Further large-scale studies are needed to refine the indications for PGT-A and confirm its long-term ben-

efits in diverse patient populations. Understanding these differences is crucial for both reproductive specialists and patients in making informed decisions regarding the use of genetic testing in IVF cycles [13].

Conclusion

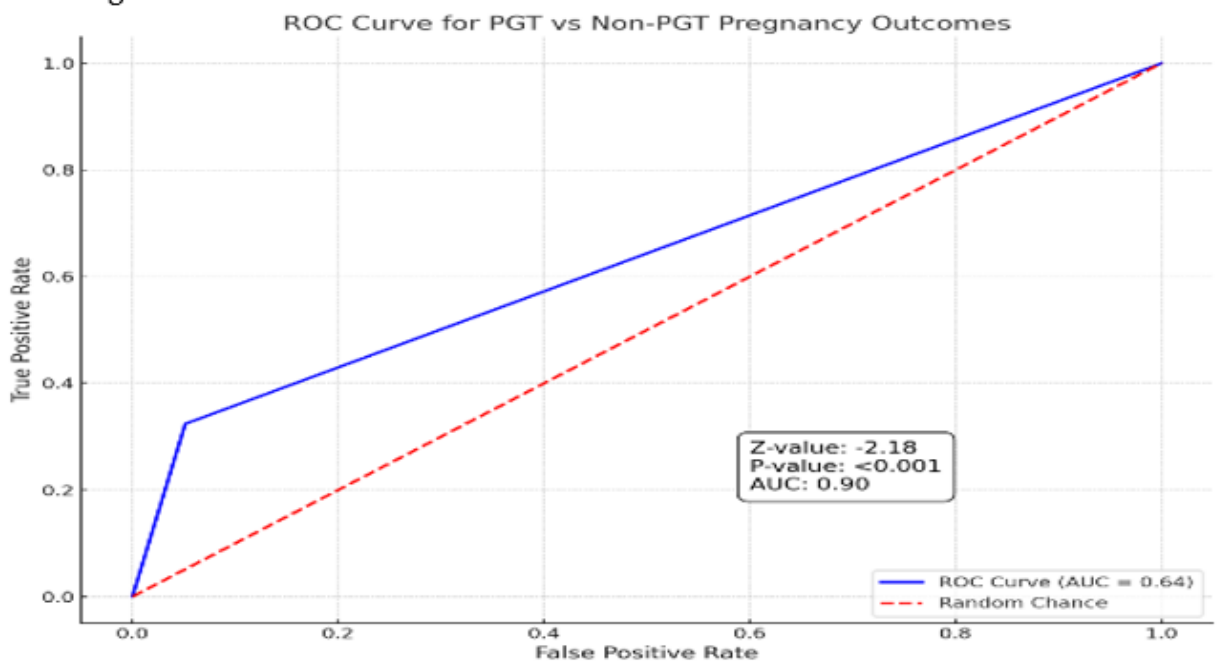
PGT-A offers a significant advantage in improving pregnancy outcomes by selecting euploid embryos and reducing miscarriage rates. However, its routine use should be tailored to patient-specific factors. Further large-scale studies are needed to optimize patient selection criteria for PGT-A, ensuring its application is both cost-effective and beneficial for intended parents

Figure 1



A graphical comparison of pregnancy outcomes following the transfer of genetically tested (PGT-A) and non-tested embryos. The data demonstrate higher pregnancy rates and lower miscarriage rates in the PGT-A group

Figure 2



ROC curve analysis comparing pregnancy outcomes between PGT-A and non-PGT-A embryo transfers. The logistic regression analysis reveals a statistically significant difference between the two groups, with an AUC of 0.90, demonstrating the model's strong predictive accuracy for distinguishing pregnancy outcomes based on embryo genetic testing

Table 1. Patient Inclusion Criteria and Average Indicators

Parameter	Average Value
Age	25.0 - 35 years
AMH (ng/mL)	4.2 ± 2.0
Antral Follicle Count (AFC)	24.7 ± 7.6
BMI	21.9 ± 2.4
Follicle-Stimulating Hormone (FSH) (mIU/mL)	7.8 ± 2.1
Thyroid-Stimulating Hormone (TSH) (mIU/mL)	2.2 ± 1.3
Prolactin (PRL) (ng/mL)	16.3 ± 5.7
Sperm Parameters	Normal

Table 2. Ovarian Stimulation Parameters

Parameter	Mean Value ± SD
FSH Level at Downregulation (mIU/mL)	3.6 ± 2.5
Estradiol (E2) Level at Downregulation (pg/mL)	10.4 ± 8.6
Total Gonadotropins Administered (IU)	3203 ± 536
Stimulation Duration (Days)	10.5 ± 2.1
E2 Level on Trigger Day (pg/mL)	7325 ± 1567
Follicle Diameter at Retrieval (mm)	18.4 ± 1.7
Total Retrieved Oocytes	19.3± 5.5

References

1. Yan J, Qin Y, Zhao H, Sun Y, Gong F, Li R, et al. Live Birth with or without Preimplantation Genetic Testing for Aneuploidy. New England Journal of Medicine. 2021;385(22).
2. Hu M, Liu M, Tian S, Guo L, Zang Z, Chen ZJ, et al. Comparative analysis of pregnancy outcomes in preimplantation genetic testing for aneuploidy and conventional in vitro fertilization and embryo transfer: a stratified examination on the basis of the quantity of oocytes and blastocysts from a multicenter randomized controlled trial. Fertil Steril. 2024;122(1).
3. Aharon D, Gounko D, Lee JA, Mukherjee T, Copperman AB, Sekhon L. Preimplantation genetic testing for aneuploidy in donor oocyte ivf cycles: a matched, sibling oocyte cohort study. Fertil Steril. 2020;114(3).
4. Liang Z, Wen Q, Li J, Zeng D, Huang P. A systematic review and meta-analysis: clinical outcomes of recurrent pregnancy failure resulting from preimplantation genetic testing for aneuploidy. Vol. 14, Frontiers in Endocrinology. 2023.
5. Cimadomo D, Fabozzi G, Vaiarelli A, Ubaldi N, Ubaldi FM, Rienzi L. Impact of maternal age on oocyte and embryo competence. Vol. 9, Frontiers in Endocrinology. 2018.
6. Frick AP. Advanced maternal age and adverse pregnancy outcomes. Vol. 70, Best Practice and Research: Clinical Obstetrics and Gynaecology. 2021.
7. Charkviani T, Chkonia L, Kurashvili N, Kutchukhidze N, Zhorzholadze T, McCulloh D. Administration of the first 2 doses of gonadotropin at twice the dose during controlled ovarian hyperstimulation decreases total gonadotropin administration during in vitro fertilisation(IVF) cycle. Fertil Steril. 2014;102(3).
8. H. McCulloh D, M. Colon J, G. McGovern P. Modeling Follicle Stimulating Hormone Levels in Serum for Controlled Ovarian Hyperstimulation III: Improved Gonadotropin Administration. Curr Pharm Biotechnol. 2012;13(3).
9. McCulloh DH, Kutchukhidze N, Charkviani T, Zhorzholadze T, Barbakadze T, Munné S, et al. Follicle size indicates oocyte maturity and blastocyst formation but not blastocyst euploidy following controlled ovarian hyperstimulation of oocyte donors. Human Reproduction. 2020;35(3).
10. Morales C. Current Applications and Controversies in Preimplantation Genetic Testing for Aneuploidies (PGT-A) in In Vitro Fertilization. Vol. 31, Reproductive Sciences. 2024.
11. Fauser BCJM, Diedrich K, Bouchard P, Matzuk FD, Franks S, Hamamah S, et al. Contemporary genetic technologies and female reproduction. Hum Reprod Update. 2011;17(6).
12. Sanders KD, Silvestri G, Gordon T, Griffin DK. Analysis of IVF live birth outcomes with and without preimplantation genetic testing for aneuploidy (PGT-A): UK Human Fertilisation and Embryology Authority data collection 2016–2018. J Assist Reprod Genet. 2021;38(12).
13. Simon JP, Pradervand PA, Cina V, Superti-Furga A, Primi MP, Leyvraz-Recrosio C, et al. Preimplantation genetic testing: Legal and ethical aspects in clinical practice. Rev Med Suisse. 2019;15(668).
14. Penzias A, Bendikson K, Butts S, Coutifaris C, Falcone T, Fossum G, et al. The use of preimplantation genetic testing for aneuploidy (PGT-A): a committee opinion. Fertil Steril. 2018;109(3).
15. Haviland MJ, Murphy LA, Modest AM, Fox MP, Wise LA, Nillni YI, et al. Comparison of pregnancy outcomes following preimplantation genetic testing for aneuploidy using a matched propensity score design. Human Reproduction. 2020;35(10).
16. Gardner DK, Lane M, Stevens J, Schlenker T, Schoolcraft WB. Blastocyst score affects implantation and pregnancy outcome: Towards a single blastocyst transfer. Fertil Steril. 2000;73(6).
17. Scott RT, Ferry K, Su J, Tao X, Scott K, Treff NR. Comprehensive chromosome screening is highly predictive of the reproductive potential of

human embryos: A prospective, blinded, nonselection study. Fertil Steril. 2012;97(4).
18. Dahdouh EM, Balayla J, García-Velasco JA. Comprehensive chromosome screening improves embryo selection: A meta-analysis. Fertil Steril. 2015;104(6).
19. E.M. D, J. B. Preimplantation genetic screening using comprehensive chromosome screening technology improves embryo selection: A meta-analysis of randomized controlled trials. Vol. 30, Human Reproduction. 2015.
20. Facadio Antero M, Singh B, Pradhan A, Gornet M, Kearns WG, Baker V, et al. Cost-effectiveness of preimplantation genetic testing for aneuploidy for fresh donor oocyte cycles. F and S Reports. 2021;2(1).
21. Neal SA, Morin SJ, Franasiak JM, Goodman LR, Juneau CR, Forman EJ, et al. Preimplantation genetic testing for aneuploidy is cost-effective, shortens treatment time, and reduces the risk of failed embryo transfer and clinical miscarriage. Fertil Steril. 2018;110(5).
22. Ni Y, Shen H, Yao H, Zhang E, Tong C, Qian W, et al. Differences in Fertility-Related Quality of Life and Emotional Status Among Women Undergoing Different IVF Treatment Cycles. Psychol Res Behav Manag. 2023;16.
23. Kuhlmann E, Scharli P, Schick M, Ditzen B, Langer L, Strowitzki T, et al. The Posttraumatic Impact of Recurrent Pregnancy Loss in Both Women and Men. Geburtshilfe Frauenheilkd. 2023;83(1).
24. Lohmann-Bigelow J, Longo SA, Jiang X, Robichaux AG. Does dilation and curettage affect future pregnancy outcomes? Vol. 7, Ochsner Journal. 2007