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Preimplantation genetic diagnosis as a tool for embryo selection in IVF.

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SUMMARY

Introduction: Preimplantation Genetic Diagnosis (PGT) has become an important tool in embryo selection during in vitro fertilization (IVF) cycles, allowing the identification of genetic and chromosomal abnormalities before embryo transfer. Its use has contributed to greater precision in selecting embryos with higher implantation potential and lower risk of genetic abnormalities. Methodology: This is an integrative literature review, conducted through structured searches in the PubMed, Virtual Health Library, and Google Scholar databases, considering articles published in the last 10 years. Results: The study comprised 21 articles selected from scientific databases, applying the inclusion criteria related to the topic. Discussion: The studies showed that PGT, especially in the PGT-A modality, contributes to increased implantation rates in live births and reduces spontaneous abortions, mainly in women of advanced maternal age. Limitations related to embryonic mosaicism, potential diagnostic errors, and ethical issues associated with embryonic selection were also identified. Furthermore, new approaches, such as non-invasive PGT and the use of artificial intelligence (AI), have shown promising potential for optimizing embryonic selection. Final considerations: In summary, PGT represents a relevant tool in reproductive medicine, contributing to greater efficiency in embryonic selection and better clinical outcomes in IVF. However, its use must be judicious, associated with other embryonic evaluation strategies and considering the ethical, clinical, and technological aspects involved in assisted reproduction.

Descriptors: *Preimplantation Genetic Testing, Fertilization in Vitro, Embryo Selection, Aneuploidy, Euploidy.*

1 INTRODUCTION

Infertility is a condition that affects between 10 and 15% of couples of reproductive age. establishing itself as a significant global public health problem. In this context, the In vitro fertilization (IVF) has become established as one of the main therapeutic strategies, allowing that individuals and couples with reproductive difficulties achieve pregnancy. However, despite the Despite technological advancements, IVF success rates remain limited and significantly affected. influenced by embryonic quality, especially by the presence of aneuploidies, which They compromise implantation and increase the risk of spontaneous abortions (ADAMYAN et al., 2024).

Traditionally, embryonic selection is based on morphological evaluation, considering aspects such as the number of cells, symmetry, and degree of fragmentation. However, this approach It presents important limitations, since morphologically adequate embryos may

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Presenting chromosomal abnormalities that are not visually detectable. In this scenario, the diagnosis...
Preimplantation Genetic Testing (PGT) is emerging as a
a complementary tool, allowing for genetic analysis of embryos before transfer to the
uterus. PGT includes different modalities, such as PGT-A, aimed at detecting
aneuploidies; the PGT-M, targeted at monogenic diseases; and the PGT-SR, used in the identification of aneuploidies.
of structural rearrangements (YAN et al., 2025).

Advances in genomic technologies have significantly boosted the accuracy of PGT.
Methods initially used, such as Fluorescence in situ hybridization (FISH), were
progressively replaced by more comprehensive techniques, such as Genomic Hybridization.
Comparative (CGH), Microarray (aCGH), SNP array, a technique based on the analysis of
single nucleotide polymorphisms (SNPs) and, more recently,
Next-Generation Sequencing (NGS), currently considered the gold standard. These technologies
They allow for a more detailed analysis of the embryonic genome, including the detection of aneuploidies.
Microdeletions and mosaicisms contribute to safer and more efficient embryonic selection.
(LEE et al., 2021; SOUSA et al., 2022).

From a clinical standpoint, evidence indicates that the use of PGT, especially PGT-A,
It is associated with an increase in implantation and live birth rates, as well as a reduction in...
spontaneous abortions, particularly in women of advanced maternal age. However, their
Benefits may vary depending on the patient's profile, being less pronounced in some individuals.
younger individuals, with a lower incidence of chromosomal abnormalities (GLEICHER et al., 2020; LEVINE et al.,
2020). Furthermore, PGT-M plays a key role in preventing the transmission of
hereditary genetic diseases, while PGT-SR contributes to better reproductive outcomes.
in couples with structural chromosomal abnormalities.

Despite the advances, the use of PGT is not without limitations. Technical issues, such as...
The presence of mosaicism and the possibility of false-positive or false-negative results may
impact the interpretation of the results. Furthermore, the embryonic biopsy procedure, although
Although considered safe, it still raises concerns about potential effects on development.
embryonic. At the same time, the high cost of the procedure and restricted access pose challenges.
important to its wide clinical application (CIMADOMO et al., 2020).

In addition to its technical limitations, PGT raises important ethical, legal, and social debates.
Embryo selection based on genetic information raises questions about autonomy.
reproductive, the risk of eugenic practices, and the discarding of embryos deemed unviable. Furthermore,
Unequal access to technology can widen social disparities in reproductive health.
In this context, proper regulation and genetic counseling become fundamental for

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to guarantee the ethical and responsible use of this tool (GINOZA; ISASI et al., 2020).

New approaches are being developed to make embryonic selection even more effective. efficient and less invasive. Among them, non-invasive PGT (niPGT), based on analysis, stands out. of cell-free DNA present in the embryonic culture medium, in addition to the integration of technologies such as Time-lapse systems and artificial intelligence, which allow for the evaluation of morphokinetic patterns. associated with embryonic viability. These innovations point to a promising future in Reproductive medicine, although it requires robust scientific validation before its widespread application. clinic (BAKALOVA et al., 2025; MINA et al., 2025).

Given this scenario, the increasing incidence of infertility, coupled with the limitations of the techniques... Traditional embryonic selection methods highlight the need for more precise, safe, and effective strategies. individualized. PGT represents not only a technological advancement, but also a change. a paradigm shift in assisted reproduction, by incorporating genetic analysis as a central tool in clinical decision-making. Thus, understanding its applications, benefits, limitations, and implications. Ethics become fundamental for improving practices in reproductive medicine.

Therefore, the present study aimed to analyze Pre-Genetic Diagnosis. Implantation as a tool for embryonic selection in in vitro fertilization cycles. highlighting its contributions, limitations, and ethical implications in the practice of reproductive medicine.

2 METHODOLOGY

This study is an integrative literature review. The literature search was... carried out between August and December 2025, through structured searches in the databases. from PubMed data, Virtual Health Library, Google Scholar, without language restrictions, selecting articles published in the last 10 years, using the following descriptors obtained from Based on a search in the Health Sciences Descriptors (DeCS): *Preimplantation Genetic Testing, In Vitro Fertilization, Embryo Selection, Aneuploidy, Euploidy,* which were combined with the Boolean AND connector. Structured searches included combinations such as: *Preimplantation Genetic Testing AND Fertilization in Vitro, PGT AND Embryo Selection, Aneuploidy AND Euploidy AND FIV.*

The inclusion criteria were articles available in full that addressed the use of PGT. in embryonic selection in IVF cycles, with analyses of efficacy, safety, and detection techniques. of aneuploidies and clinical outcomes.

As exclusion criteria, duplicate articles and articles with restricted access were considered, that addressed other preimplantation genetic diagnosis methods that did not include PGT,

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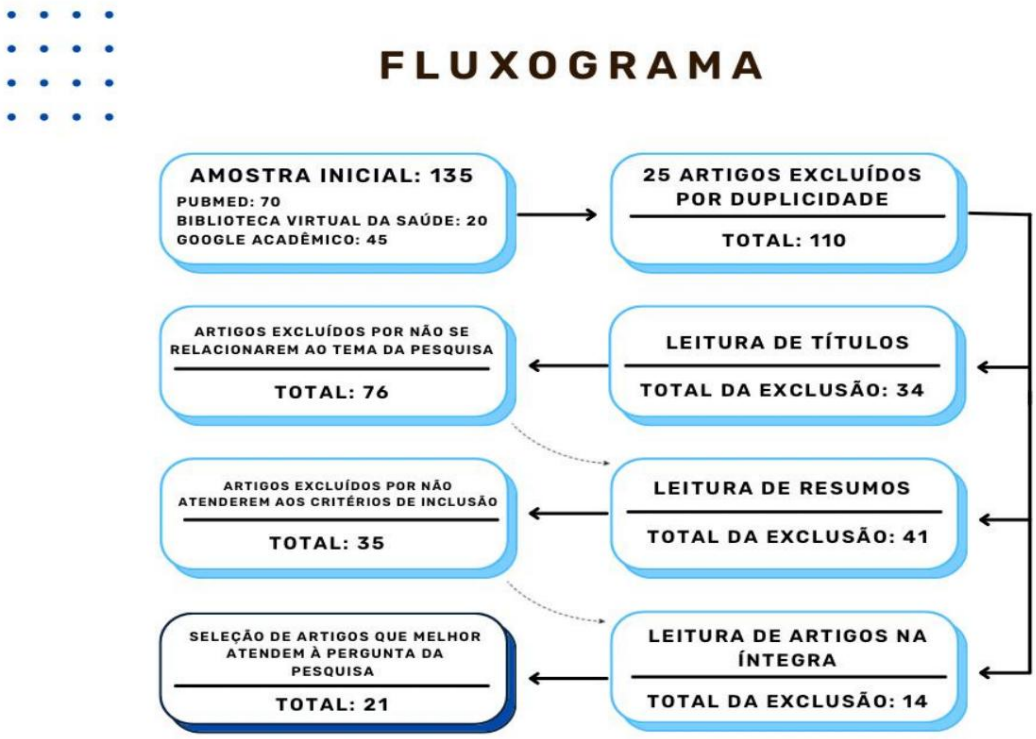
or that were not related to IVF, in addition to studies conducted in animal models.

3 RESULTS

Based on a structured search conducted in the PubMed and Virtual Library databases...
Using the Health and Google Scholar databases, 135 studies were identified: 70 from PubMed and 20 from the Virtual Library.
in Health and 45 from Google Scholar. After removing 25 duplicate studies, 110 articles remained.
for analysis. Next, the titles were read, a step in which 34 studies were excluded.
because they do not have a direct relationship with the research topic.

Subsequently, the abstracts of the selected studies were read, which resulted in...
41 articles were excluded for not meeting the established inclusion criteria. Thus, 35 studies were selected.
They were then read in full. After a complete analysis of the texts, 14 articles were excluded because
They do not directly address the proposed topic, either by using animal models or by presenting...
Insufficient data for the research. At the end of the selection process, 21 studies were included in the
review, comprising the final corpus of the analysis (Figure 1).

Figure 1. Flowchart for article selection, 2026.



Source: Author's own work, 2026.

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Among the 21 articles selected for this integrative review, the evidence was examined. Scientific studies on preimplantation genetic diagnosis (PGT) as a screening tool Embryonic cell count in in vitro fertilization (IVF) cycles. The main points investigated involved the application of PGT-A in the identification of embryonic aneuploidies, its contribution to improvement of reproductive outcomes, as well as their clinical and methodological limitations.

Other procedures were also considered, such as PGT-M and PGT-SR, as well as aspects related to embryonic mosaicism and the development of new approaches, such as such as non-invasive PGT and the use of artificial intelligence.

The main characteristics of the selected studies are presented in Table 1.

Table 1. Characteristics of the selected scientific articles, according to title, authors, year of publication, objectives and results, 2026.

Title	Authors Year	Objective	Results
Preimplantation genetic testing PGT-A improves implantation rates and reduces miscarriages. Evaluate the effectiveness of PGT-A *for*	Adamyan et al. 2024	*aneuploidy in patients of* PGT-A in different *age groups:*	advanced age.
a systematic review, especially in women of different age ranges.			
review and meta-analysis			
invasive preimplantation (niPGT) Bakalova et al. Review the use of PGT. promising, but still not			The niPGT shows potential. *Non-* nvasive. 2025
testing			requires clinical validation *from genetic* Regarding its accuracy.
Capalbo and its diagnostic possibilities,	ncluding polygenic risk in 2024.	of *screening embryos for*	The approach broadens the discussion
polygenic disease risk: a review	al. but it raises ethical questions and embryos		clinical limitations.
preimplantation method . Evaluate the use of complementary niPGT, although *genetic testing*			It can act as a *non-invasive*
al. 2025).		as an alternative to limitations,	*using blastocysts* is still needed (Chen et present *medium*
		embryonic biopsy	diagnostic.
Practices and ethical concerns. Analyzing ethical aspects. Highlighting concerns. Damian et al.		*regarding pre-implantation.* 2015	
		pre-diagnosis related to regulation, ethics, and *genetic diagnosis .*	
		implantation	and inequality in access.
regulating preimplantation genetic testing and reviewing the limitations of mosaicism and			It points out challenges such as
	al.	possible errors *in genetic testing across the world.* PGT	diagnoses.
Preimplantation genetic testing Kemper et al. Review applications from 2019 but highlights			Confirms clinical benefits,
	al.	limitations *for aneuploidy: a review* PGT	methodological.
Preimplantation genetic L'Heveder et al. *testing:*		PGT's	Analyze the current state of technological capabilities in 2021.
current perspectives			Evidence: advances and challenges clinical.
outcomes of recurrent disease: Results suggest improvement (Liang et al. 2023)			Assessing the impact of *clinical*
failure and PGT-A			PGT-A in failures *pregnancy* recurrent reproductive cycles
			in clinical outcomes.
Artificial intelligence in embryos (Mina et al. 2025): Evaluating the use of AI in intelligence.			artificial

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Title	Authors Year Objective			Results
assessment			selection embryonic	It shows potential in predicting reproductive success.
Status of preimplantation genetic testing	et al.'s 2018	growth in	reviews the evolution of Munné application. PGT	Shows technological advances and clinic.
strategies of Calonge et al. 2024 genetics	Nunez-	Integra	morphological evaluation and *making and* as an approach .	*selecting the best embryo* . Discussing ideal.
	al.		embryonic selection	
Embryo selection through Comparing intelligence AI can complement *artificial intelligence versus*			artificial evaluation with traditional	Salih et al. 2023 al evaluation performed *by embryologists* by embryologists.
			human	
et al. 2021 quality .			Investigating factors that influence genes: Gamet genetic factors directly related to *embryo*	*ic factors as markers of* development and embryonic embryonic.
Non-invasive preimplantation genetic testing: the literature review	Sousa; Monteiro	2022	Review of niPGT	A promising method, but still undergoing clinical validation.
preimplantation genetic testing . Review	applications of PGT (Tian et al. 2024) despite the		limitations *in the current era* .	Confirms the clinical relevance of existing.
chromosomal inversion therapy (PGT) in *Carriers need*	patients with the	disease	Assessing the need for . The indication should be chromosomal	Tong et al. 2022 individualized PGT inversions.
Ethical reflections highlight moral dilemmas and discuss ethical and social aspects related to the use of *preimplantation genetics* (Wang et al. 2024)				
diagnosis				technique.
Ethical perspectives on preimplantation genetic testing	et al. 2022	related to	Assessing perceptions Zhang ethics about PGT	Evidence concerns about the selection embryonic.
PGT for structural rearrangement detection . Evaluate the use of SNPs in Zhang et al. 2025.				The method showed effectiveness in structural.

4. DISCUSSION

The studies analyzed demonstrate that Preimplantation Genetic Diagnosis (PGT) has assumed an increasingly important role in reproductive medicine, especially in the context from in vitro fertilization (IVF). The incorporation of genetic analysis into embryonic selection has allowed important advances in identifying embryos with greater implantation potential, contributing for improved reproductive outcomes and to reduce pregnancy loss. In this context, PGT-This stands out as the most widely used modality in clinical practice, mainly due to its ability. to detect embryonic aneuploidies before transfer to the uterus.

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According to Adamyan et al. (2024), the use of PGT-A is associated with increased rates.
implantation and live birth rates, as well as a reduction in spontaneous abortion rates,
especially in patients with advanced maternal age. Similarly, Liang et al. (2023)
They observed a significant improvement in clinical outcomes in patients with reproductive failures.
recurring cases submitted to PGT-A. These results demonstrate that the prior identification of
Embryonic chromosomal abnormalities may contribute to greater efficiency in IVF cycles.
reducing the transfer of non-viable embryos and increasing the chances of successful pregnancy.

Despite this, it is observed that the benefits of PGT-A do not manifest themselves homogeneously.
in all patient profiles. Tian et al. (2024) emphasize that the effectiveness of the method is
directly related to individual clinical and reproductive characteristics, especially age.
maternal history, abortion history, and number of previous implantation failures. Tong et al. (2022)
They also emphasize that the indiscriminate use of PGT may not result in clinical benefits.
Significant in young patients with a low incidence of aneuploidies. Thus, it is evident
the need for individualized therapy in assisted reproduction, avoiding both underutilization
as well as the overuse of the technique.

In this context, embryonic selection based exclusively on morphological criteria
It has important limitations. Although morphological analysis continues to be widely used.
In embryology laboratories, several studies demonstrate that morphologically...
Suitable fetuses may present chromosomal abnormalities incompatible with gestational development.
Núñez-Calonge et al. (2024) state that the association between morphological assessment and genetic analysis
This currently represents the most efficient strategy for optimizing IVF results. Thus, the
PGT does not completely replace morphological assessment, but acts as a complementary tool.
capable of increasing the accuracy in embryo selection.

In addition to PGT-A, other PGT modalities also have great clinical applicability in
Contemporary reproductive medicine. PGT-M plays a key role in the prevention of
transmission of monogenic hereditary diseases, allowing the identification of mutation-free embryos.
associated with serious genetic diseases. Giuliano et al. (2023) highlight that this modality
It provides greater reproductive safety for families with a history of hereditary diseases.
reducing the risk of genetic transmission and expanding family planning possibilities.
In this way, the PGT-M goes beyond the objective of improving implementation rates, also assuming the role of...
an important preventive and social impact.

Similarly, PGT-SR is highly relevant for couples with rearrangements.
structural chromosomal abnormalities, such as translocations and inversions. Zhang et al. (2025) demonstrated that the
The use of single nucleotide polymorphisms (SNPs) associated with PGT-SR shows high efficacy.

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in the identification of chromosomally balanced embryos, contributing to the reduction of recurrent miscarriages and implantation failures. Tong et al. (2022) reinforce that the use of this The modality must be carefully individualized, considering the type of rearrangement. Chromosomal characteristics and the couple's clinical history. Thus, it is observed that the different modalities of PGT has specific indications, which reinforces the need for a personalized approach in assisted reproduction.

Another relevant aspect identified in the studies refers to the technological evolution of PGT. over the last few decades. Initially, techniques such as fluorescence in situ hybridization (FISH) They allowed the analysis of only a limited number of chromosomes, with low coverage. diagnostic. With the advancement of genomic technologies, more comprehensive methods have become available. used, including Comparative Genomic Hybridization (CGH), the genomic microarray. (aCGH) and the SNP array. Currently, Next-Generation Sequencing (NGS) is considered the The gold standard in embryonic genetic analysis, due to its high sensitivity and ability to... detect aneuploidies, microdeletions and mosaicisms with greater precision (L'HEVEDER et al., 2021; TIAN et al., 2024).

Munné et al. (2018) state that the evolution of these techniques has allowed for a progressive increase of the diagnostic reliability of PGT and the expansion of its clinical application. Furthermore, Sang et al. (2021) highlight that genetic factors directly influence embryonic quality, highlighting the importance of molecular analysis in the context of IVF. Therefore, advances Technological advancements have not only expanded the diagnostic capabilities of reproductive medicine, but also... significantly altered the understanding of embryonic viability and potential. implantation.

Despite the observed benefits, PGT still has significant technical limitations. Among them, embryonic mosaicism constitutes one of the main current challenges in reproduction. assisted. Giuliano et al. (2023) highlight that embryos classified as aneuploid may, in In some cases, they result in viable pregnancies, which highlights the complexity of genetic interpretation. embryonic stage. This scenario highlights the presence of different cell lineages in the same The presence of an embryo can compromise the diagnostic accuracy of PGT-A and hinder clinical decision-making.

Furthermore, Kemper et al. (2019) and L'Heveder et al. (2021) emphasize that the occurrence of False-positive and false-negative results represent a significant methodological limitation. Although trophoblast biopsy is considered relatively safe, there are still discussions about it. Possible impacts of embryonic manipulation on the subsequent development of the embryo. In this way, the authors emphasize that PGT should not be interpreted as an infallible method, but rather as a complementary tool, integrated into the clinical and laboratory context.

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Another important point concerns the expectations associated with the use of PGT. Many patients Those undergoing assisted reproduction associate the technique with a guarantee of successful pregnancy, which may This can generate frustration when faced with negative results. However, studies show that, although the PGT increases the chances of implantation and reduces pregnancy loss, but it does not eliminate the risk of pregnancy. completely factors associated with infertility, such as uterine abnormalities, immunological factors and Maternal hormonal conditions. Therefore, the use of PGT should be accompanied by guidance. adequate genetic counseling, allowing patients to understand the real benefits and limitations of the technique.

The ethical, legal, and social implications associated with PGT also occupy a central position in Current discussions on assisted reproduction. Wang et al. (2024) and Zhang et al. (2022) highlight that the possibility of embryonic selection based on genetic information goes beyond questions exclusively clinical, involving moral reflections related to reproductive autonomy, to embryonic disposal and possible eugenic practices. Although the main objective of PGT is To prevent genetic diseases and improve reproductive outcomes, there is concern regarding the use of... Inadequate use of technology for selecting non-therapeutic features.

Capalbo et al. (2024) expand on this discussion by addressing polygenic risk screening in embryos. According to the authors, the possibility of assessing genetic predisposition to diseases Multifactorial approaches significantly expand the potential of embryonic selection, but also intensify... ethical debates about the limits of human genetic intervention. In this context, it becomes It is necessary to establish clear regulations and bioethical principles capable of guiding the use. responsible for these technologies.

Furthermore, unequal access to reproductive technologies constitutes a significant challenge. social. Damian et al. (2015) emphasize that the high cost of PGT restricts its use to a portion limited population, contributing to the widening of inequalities in access to healthcare. reproductive. Thus, it is observed that scientific advances are not always accompanied by democratization of access, which reinforces the need for public policies and regulations that ensure greater equity in the use of these technologies.

In this context, Ginoza and Isasi et al. (2020) highlight that the international regulation of PGT (Progressive Governance) shows great variability between countries, reflecting ethical, cultural, and legal differences. Regarding assisted reproduction, the authors emphasize that genetic counseling and action are crucial. Multiprofessional teams are essential to ensure ethical, informed, and effective decision-making. individualized. Therefore, the use of PGT must occur responsibly, considering not not only technical aspects, but also the emotional, social and bioethical implications involved in reproductive process.

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Meanwhile, new technologies are being developed to make embryonic selection more efficient. more efficient and less invasive. Among these approaches, non-invasive PGT (niPGT) stands out. based on the analysis of cell-free DNA present in the embryonic culture medium. Bakalova et al. (2025) and Sousa and Monteiro et al. (2022) describe niPGT as a promising alternative to biopsy. conventional embryonic transplantation, especially because it reduces the risks associated with cell manipulation. However, studies also show that the technique still has limitations, such as... contamination of genetic material and variability in results.

Chen et al. (2025) reinforce that niPGT can act as a complementary tool to PGT. traditional, but still needs further scientific validation regarding its diagnostic accuracy and laboratory standardization. Thus, although it represents a promising prospect for the future of assisted reproduction, its widespread clinical application still depends on further studies that prove their safety and diagnostic reliability.

In addition to niPGT, the incorporation of artificial intelligence (AI) in embryonic assessment This represents another important technological advance in contemporary reproductive medicine. Mina et al. (2025) demonstrated that models based on artificial intelligence have potential significant for predicting embryonic implantation and gestational success, especially through from the analysis of morphokinetic patterns obtained in time-lapse systems.

Similar results were described by Salih et al. (2023), who observed performance comparable to, or even superior to, AI assessments performed by human embryologists. Despite the promising results, the authors emphasize that many studies still present... methodological limitations, such as small samples and retrospective analyses, reinforce the The need for prospective validation before these tools are definitively incorporated into practice. clinic.

Thus, the studies analyzed show that PGT represents one of the main advances in contemporary reproductive medicine, contributing significantly to the The goal is to improve embryonic selection and optimize IVF results. However, its Its use still involves technical, ethical, economic, and social challenges that require careful analysis. and an individualized approach. Thus, PGT should be understood as a tool complementary in assisted reproduction, integrated with clinical, laboratory and genetic evaluation, always considering ethical principles, patient safety, and the current limitations of technology.

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FINAL CONSIDERATIONS

This study demonstrated that PGT represents an important complementary tool.
in in vitro fertilization (IVF), contributing to greater precision in embryo selection and to
better reproductive outcomes. Analysis of the studies demonstrated that the use of PGT is
primarily associated with a reduction in embryonic aneuploidies and a decrease in miscarriages.
spontaneous and increased implantation and live birth rates, especially in patients
with advanced maternal age and unfavorable reproductive history.

Furthermore, it was observed that technological advances in reproductive medicine,
especially related to Next-Generation Sequencing (NGS), non-invasive PGT and
Artificial intelligence applied to embryonic evaluation has been significantly expanding the
diagnostic and therapeutic possibilities of assisted human reproduction. However, studies
The analyses also revealed the existence of technical limitations, ethical challenges, and inequalities.
in accessing these technologies, reinforcing the need for careful, individualized use and
ethically responsible PGT.

In this context, the relevance of the biomedical professional's role in human reproduction is also highlighted.
assisted, especially in the laboratory processes involved in IVF and PGT. Participation
This professional's role contributes directly to the execution of genetic analyses and manipulation.
embryonic development, laboratory quality control, and the application of technologies aimed at selection.
embryonic development plays a fundamental role in the safety and effectiveness of treatments.
reproductive.

Therefore, it can be concluded that PGT represents an important advancement in reproductive medicine.
contemporary, presenting significant potential for optimizing clinical outcomes in IVF.
However, further studies are needed to enable greater standardization and accessibility.
and validation of emerging technologies, aiming to increase safety, effectiveness, and democratization.
of these techniques in the context of assisted reproduction.

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