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# Systematic Comparison of Short-Term Insemination and Conventional Insemination IVF: Influencing Factors, Embryo Developmental Quality and Pregnancy Outcomes

Yunyue Tan[1]

[1] Assisted Reproductive Center, The First Affiliated Hospital of Chongqing Medical University, Chongqing, China

Correspondence: Yunyue Tan, Assisted Reproductive Center, The First Affiliated Hospital of Chongqing Medical University, Chongqing, China.

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**Abstract**

In in vitro fertilization-embryo transfer (IVF-ET), the selection of insemination duration is a key variable affecting pregnancy outcomes. This paper systematically compares the differences between two insemination strategies, namely short-term insemination (4-6 hours) and conventional IVF (16-18 hours), in terms of influencing factors, embryo development and pregnancy outcomes, aiming to provide evidence-based basis for the selection of individualized insemination protocols. Studies have shown that the choice of insemination method should be based on a comprehensive assessment of patients' clinical characteristics, oocyte status and sperm function parameters. Analysis of embryo development kinetics indicates that embryos from short-term insemination have more synchronous pronuclear formation and early cleavage, and a shorter time to blastocyst formation. However, there is no significant difference in the overall blastocyst formation rate and live birth rate between the two methods. By reducing the exposure time to reactive oxygen species, short-term insemination shows advantages in populations with high oxidative stress (such as polycystic ovary syndrome (PCOS) and oocytes derived from small follicles) and specific male factors (such as oligozoospermia and asthenospermia). It can improve fertilization rate, high-quality embryo rate and early pregnancy rate, and may reduce the risk of early miscarriage. In contrast, conventional insemination may be more conducive to embryo implantation and maintenance of continuous pregnancy in women with high oocyte maturity (MII rate > 80%) and advanced age (≥38 years old). Current studies have limitations such as insufficient standardization of laboratory procedures and high population heterogeneity. In the future, it is necessary to further clarify the optimal insemination strategy for different populations through unified operation standards, refined stratified studies and long-term follow-up, so as to promote the precision and individualization of IVF insemination protocols.

**Keywords:** in vitro fertilization, short-term insemination, conventional insemination, embryo development, pregnancy outcome, individualized treatment

## 1. Introduction

In vitro fertilization-embryo transfer (IVF-ET) technology serves as the core approach in the field of assisted reproduction, and its successful implementation relies on the critical process of sperm-egg fusion. The selection of insemination duration (i.e., the co-incubation time of sperm and oocytes) is an important controllable variable that affects the subsequent trajectory of embryo development and clinical outcomes (Chinese Society of Reproductive Medicine, 2020). Traditional conventional insemination adopts a 16–18-hour co-incubation period, aiming to simulate the physiological fertilization window in vivo; in contrast, short-term insemination shortens the co-incubation time to 4–6 hours, with early observation of the extrusion of the second polar body and, when

necessary, adjuvant early rescue intracytoplasmic sperm injection (ICSI) (Fancsovits, P, Kaszas, Z, Nemes, A, et al., 2020). These two strategies not only represent differences in the time dimension, but also may regulate the epigenetic modification and developmental potential of embryos by altering the microenvironment of sperm-egg interaction, the level of reactive oxygen species (ROS) exposure, and the impact of sperm DNA fragmentation on zygotes (Soto-Heras S, Sakkas D, Miller DJ., 2023; Li L, Liao H, Li M, et al., 2022).

Although randomized controlled trials suggest that there is no statistically significant difference in the overall pregnancy rate and live birth rate between the two insemination methods (Jiang Yan, Zhang Han, Zhang Xuhui, et al., 2021; Sha T, Wang X, Cheng W, et al., 2019), their efficacy shows notable heterogeneity among patient populations with different etiologies and physiological states. This heterogeneity may be related to the interaction of complex factors such as oocyte maturity, mitochondrial function, sperm parameters, and oxidative stress status (Vaiarelli A, Cimadomo D, Alviggi E, et al., 2020; De Munck N, El Khatib I, Abdala A, et al., 2020). At present, the selection of insemination methods in clinical practice is mostly based on empirical consensus, lacking unified and precise decision-making criteria. Meanwhile, existing studies have obvious limitations in terms of laboratory process standardization, refined population stratification, and long-term follow-up of offspring, which restricts the extrapolation of research conclusions.

In view of this, this paper aims to systematically sort out and compare short-term insemination and conventional insemination. We will focus on the following aspects: (1) key clinical and laboratory variables affecting the selection of insemination methods; (2) the impact of the two strategies on embryo development quality; (3) evidence-based medical comparison of clinical pregnancy outcomes. By integrating existing evidence, this paper attempts to clarify the respective advantageous scenarios and potential mechanisms of the two insemination strategies, provide theoretical basis and evidence-based reference for establishing an individualized and precise framework for selecting insemination protocols, and prospect the future research directions in this field to promote the precise development of insemination strategies.

## 2. Overview of Short-Term Insemination and Conventional IVF Insemination

In in vitro fertilization technology, the choice of sperm-oocyte co-incubation duration has led to two distinct insemination strategies: short-term insemination and conventional insemination. These two approaches reflect different philosophies regarding the control of the fertilization process. Short-term insemination emphasizes actively terminating co-incubation after the initial sperm-oocyte binding is completed, providing greater controllability for laboratory operations; in contrast, conventional insemination maintains a longer co-incubation period to simulate the complete process of sperm-oocyte interaction under physiological conditions and preserve the competitive selection mechanism in natural settings (Chamayou S., 2022).

The core advantage of short-term insemination lies in reducing the exposure time to reactive oxygen species (ROS), which theoretically lowers the potential oxidative stress-induced damage to oocytes and early embryos. Meanwhile, the limited contact time may affect the sperm selection mechanism: compared with the natural competitive mode of conventional insemination, short-term insemination tends to adopt a strategy of rapid optimal sperm selection. It is noteworthy that these two insemination methods exhibit a complementary rather than opposing relationship in practical applications. Selecting an appropriate insemination method based on the individualized characteristics of different patients can significantly improve the success rate of IVF. This decision should be made on the basis of a systematic assessment of the patient's clinical characteristics, oocyte status, sperm parameters, and other relevant factors (Zhang, R., Zuo, Y., & Qiu, F., 2021).

## 3. Key Factors Affecting the Selection of Insemination Methods

### *3.1 Clinical Characteristics of Patients*

The clinical background of patients is the primary dimension for determining the selection of insemination strategies. The primary etiology is the core consideration: for infertile couples dominated by male factors, especially when routine semen parameters (such as concentration and motility) are at critical values or the DNA Fragmentation Index (DFI) is elevated, short-term insemination is often regarded as a more advantageous option. Theoretically, it can reduce the damage of oxidative stress and DNA fragmentation to early embryos by limiting the prolonged contact between damaged sperm and oocytes. On the contrary, for patients with oocyte-derived factors or specific endocrine conditions (such as Polycystic Ovary Syndrome, PCOS), more careful trade-offs are required.

Meanwhile, female age is another independent influencing factor that cannot be ignored. Oocytes of advanced-age women (usually defined as ≥38 years old) are often accompanied by decreased mitochondrial function, elevated oxidative stress levels and abnormal epigenetic modifications, and their fertilization process may be more dependent on a complete physiological time window. Studies have indicated that in this population, conventional insemination may achieve relatively higher embryo implantation rates by simulating a longer physiological fertilization process (23.1% vs. 17.6%, P=0.04) (Huang Ying, Qin Aiping, 2020; Tesarik J,

Mendoza-Tesarik R., 2022). For PCOS patients, although they often face a follicular microenvironment with high oxidative stress, studies have shown that short-term insemination may obtain higher cumulative pregnancy rates by reducing the exposure time to such stress (52.3% vs. 42.5%, P=0.02) (Li, J., Wang, H., Zhang, Y., & Liu, Q., 2025).

In addition, patients' ovarian responsiveness (such as the number of retrieved oocytes) and previous in vitro fertilization (IVF) cycle outcomes should also serve as important references for decision-making. A large number of retrieved oocytes (e.g., >15-20) is an ideal scenario for short-term insemination. Even if some oocytes fail to fertilize naturally after short-term co-culture, there are still sufficient oocytes for rescue intracytoplasmic sperm injection (ICSI), ensuring the final total fertilization rate. For patients with a clear history of fertilization failure, selecting short-term insemination with a plan for early rescue ICSI can be adopted as an active strategic option.

*3.2 Evaluation of Oocytes*

Oocyte maturity (MII rate) is the core factor determining fertilization efficiency. In current clinical practice, evaluation is mainly based on nuclear maturation status (the proportion of germinal vesicle (GV), metaphase I (MI), and metaphase II (MII) stages). Oocytes with different maturities exhibit significant differences in their response to insemination duration. MII-stage oocytes, having completed meiosis and with sufficient expression of zona pellucida receptors, may be more suitable for conventional in vitro fertilization (IVF). In contrast, GV-stage or MI-stage oocytes may benefit from the concentrated sperm exposure in short-term insemination due to insufficient zona pellucida hardening (Chamayou S., 2022). Clinical data indicate that when the MII rate is higher than 80%, the fertilization rate of conventional insemination can reach 72.5±6.3%, which is significantly superior to that of short-term insemination (65.1±7.8%, P<0.05). However, in cycles with an MII rate lower than 60%, short-term insemination instead demonstrates higher fertilization efficiency (58.4±5.2% vs. 49.7±6.1%) (Shi Hongzhi, Qin Yan, Zhang Nan, et al., 2019). This may be related to the increased sensitivity of immature oocytes to oxidative stress.

In addition, follicular characteristics should also serve as an important reference index for the selection of insemination methods. Studies have shown that the concentration of reactive oxygen species (ROS) in the follicular fluid of small follicles with a diameter of 12–14 mm is usually maintained at a relatively high level of 2.8±0.3 nmol/mL (Artini PG, Scarfò G, Marzi I, et al., 2022). For oocytes derived from such follicles, short-term insemination can reduce the ROS exposure time, resulting in a fertilization rate of 68.5%, which is higher than that of conventional IVF (61.2%, P<0.05). This finding suggests that short-term insemination has clinical advantages for oocytes from follicles within this diameter range and is recommended as the preferred option.

*3.3 Comprehensive Evaluation of Sperm Functional Parameters*

Sperm quality assessment has expanded from traditional parameters (concentration, motility, and morphology) to the multi-dimensional integration of functional indicators. The quantity of functionally competent sperm following sperm processing constitutes the fundamental basis. For semen samples with progressive motility (PR) sperm lower than 32% or sperm concentration less than $15\times10^6$/mL, short-term insemination combined with density gradient centrifugation can increase the effective sperm capture rate to 89.3±4.1%, which is significantly higher than the 72.6±5.8% achieved with conventional processing (Yin, Z., Dong, Y., Sun, Q., Li, Z., Liu, J., Jia, Y., Dong, X., Hong, Y., Gao, J., Xiu, C., & Ma, G., 2020). Sperm DNA integrity has emerged as a crucial indicator for evaluating sperm function in recent years. A high DNA Fragmentation Index (DFI > 30%) indicates an elevated risk of sperm genomic damage. In such cases, although short-term insemination reduces the exposure duration between sperm and oocytes, it may not be sufficient to overcome the inherent DNA damage, potentially leading to a decline in embryo implantation rates (Harith Mohamed Kamber, Kamal Al-Jawdah, Salam Madhi Shahid, et al., 2024). Under these circumstances, direct intracytoplasmic sperm injection (ICSI) or short-term insemination following special treatments (e.g., magnetic-activated cell sorting) might represent a more rational approach.

Sperm morphological parameters also merit attention. Studies have demonstrated that when the rate of morphologically normal sperm reaches 60%, the clinical pregnancy rate with short-term insemination can attain 41.2%. In contrast, a sperm head abnormality rate exceeding 15% can sharply reduce the pregnancy rate to 18.5% (Lei Zhihui, Yan Yixin, Yu Yan, et al., 2024). This discrepancy may be directly associated with the efficiency of the acrosome reaction: the rate of phospholipase C zeta (PLCζ) expression deficiency in morphologically abnormal sperm heads is as high as 78.3%, which severely impairs the oocyte activation process (Cannarella R, Condorelli RA, Mongioì LM, et al., 2020).

**4. Morphological and Kinetic Comparison of Embryo Developmental Quality**

*4.1 Clinical Application and Limitations of Morphological Evaluation*

As a core quality monitoring method in in vitro fertilization (IVF) technology, embryo morphological evaluation

classifies embryos mainly by observing static indicators such as cell uniformity, fragmentation rate, and blastomere symmetry. The traditional Gardner scoring system categorizes blastocysts across three dimensions: expansion degree (grades 1–6), inner cell mass (ICM, grades A–C), and trophectoderm (TE, grades A–C). Among these, the quality of the inner cell mass is significantly positively correlated with the clinical pregnancy rate (grade A vs. grade C: 52.7% vs. 28.3%, $P<0.01$) (Devora Aharon, Atoosa Ghofranian, Dmitry Gounko, et al., 2021). However, this static observation method cannot fully reflect the dynamic process of embryo development. A study involving 1,200 embryos demonstrated that the predictive accuracy of morphological evaluation alone for high-quality embryos is only 68.5%, whereas integrating kinetic parameters from time-lapse imaging technology can increase the accuracy to 82.3% (Gao Shang, Liu Baolian, Yao Yuhong, et al., 2025; Feng Bo, Qiu Fenglong, Zhong Jixiang, et al., 2022).

The morphological differences between embryos derived from short-term insemination and conventional insemination are mainly manifested in the early developmental stage. The time to pronuclear formation (tPNf) in the short-term insemination group is 1.8 hours shorter on average than that in the conventional insemination group (15.2±2.1 h vs. 17.0±2.4 h, $P=0.03$), and the proportion of synchronized cleavage is higher (the proportion of 4-cell embryos on day 2 is 72.1% vs. 63.5%) (Nemerovsky L, Ghetler Y, Bakhshi DI, et al., 2024; Dal Canto M, Bartolacci A, Turchi D, et al., 2020). This difference may be related to the reduced exposure time to sperm DNA fragmentation. When the sperm DNA Fragmentation Index (DFI) > 30%, the rate of high-quality embryos in the short-term insemination group is 14.2% higher than that in the conventional insemination group (45.6% vs. 31.4%) (Zhang, Y., Wang, H., Liu, J., & Chen, Z., 2023).

*4.2 Predictive Value of Kinetic Parameters for Developmental Potential*

Embryonic developmental kinetics has established a refined predictive system for developmental potential by quantifying the key time points of cell division. The Cambridge IVM model has defined the reference time windows for each developmental stage. Among them, embryos with t5 (the time to reach the 5-cell stage) within the range of 24.8–28.3 hours exhibit a blastocyst formation rate of up to 78.5%, which is significantly superior to that of embryos outside this time window ($P<0.01$) (Shi Senlin, Lyu Aixiang, Song Wenyan, et al., 2019). This model provides an important temporal reference standard for embryo selection. The intercorrelation of kinetic parameters reveals the inherent laws of embryonic development. Studies have shown that in embryos derived from short-term insemination, there is a significant negative correlation between t2 (the time to reach the 2-cell stage) and tSB (the time to reach the morula stage) ($r=-0.42$, $P=0.01$), suggesting that rapid early cleavage may have a complex balance relationship with subsequent developmental potential (Sciorio, R., Thong, K. J., & Pickering, S. J., 2022; Bartolacci A, Moutier C, Turchi D, et al., 2020). This phenomenon of mutual restriction among temporal parameters needs to be fully considered during embryo evaluation.

The heterogeneity of patient populations significantly affects the kinetic characteristics of embryonic development. In patients with polycystic ovary syndrome (PCOS), the proportion of embryos with delayed tPNf (time to pronuclear formation) in the short-term insemination group is 37% lower than that in the conventional insemination group (18.9% vs 30.1%), whereas there is no statistically significant difference in the blastocyst formation rate between the two insemination methods (62.4% vs 58.7%) (Liu, Y., Zhang, X., Wang, L., & Li, J., 2025). In contrast, for advanced-age patients (≥38 years old), the coefficient of variation of kinetic parameters increases significantly, with the standard deviation of t2 reaching 3.2 hours (compared with 1.7 hours in the young group). In this population, the continuous embryo development rate (from day 3 to day 5) of conventional insemination is superior to that of short-term insemination (41.3% vs 35.8%) (Dal Canto M, Bartolacci A, Turchi D, et al., 2020; Chen, Q., Zhao, L., Wang, Y., et al., 2022).

*4.3 Regulatory Effects of Culture Environment on Developmental Quality*

As a core parameter of the culture environment, oxygen concentration exerts a systematic impact on the metabolic characteristics of embryos. Under hypoxic culture conditions (5% $O_2$), the reactive oxygen species (ROS) level of embryos derived from short-term insemination decreases by 42%, the mitochondrial membrane potential increases by 1.3-fold, and the total number of blastocyst cells rises by 19.5% (128±15 vs 107±12, $P=0.02$) (Tao Linlin, Li Guozhen, Yang Zhiwei, et al., 2020; Wang, F., Li, R., Zhang, H., et al., 2022). This finding provides an important basis for optimizing the culture environment.

The adaptability of the culture system is also a key factor affecting embryo developmental quality. Studies have confirmed that the sequential culture system exhibits better compatibility with short-term insemination—its high-quality embryo rate is 11.3% higher than that of the single culture system (58.2% vs 46.9%), and this difference becomes more pronounced when the sperm concentration is lower than $5\times10^6$/mL (Li Youzhu, Yan Xiaohong, Wu Rongfeng, et al., 2020; Pellegrini L, Gatti S, Navarro N, et al., 2024). This indicates that the selection of the culture system needs to be synergistically optimized with the insemination strategy.

**5. Evidence-Based Medical Comparison of Clinical Pregnancy Outcomes**

*5.1 Comparison of Clinical Pregnancy Rate and Live Birth Rate*

Randomized controlled trials (RCTs) provide high-level evidence to support the comparison of clinical efficacy between short-term insemination and conventional insemination. An RCT involving 320 patients with non-male-factor infertility showed that the clinical pregnancy rate in the short-term insemination group reached 52.6%, which was significantly higher than the 43.1% in the conventional insemination group (P=0.03). However, there was no statistically significant difference in the live birth rate between the two groups (41.8% vs. 38.5%, P=0.52) (Abbas AM, Hussein RS, Elsenity MA, et al., 2020). This result indicates that although short-term insemination may improve the conditions for early embryo implantation, its impact on the final live birth outcome remains to be verified.

In the population with male-factor infertility, the selection of insemination strategies presents more complex effect characteristics. Clinical trials targeting patients with oligoasthenospermia have demonstrated that when the progressive motility (PR) rate ranges from 10% to 20%, the live birth rate of short-term insemination can reach 36.4%, which is 7.2 percentage points higher than that of conventional insemination (P=0.04) (Zhang Qingjian, Song Ge, Jiang Ronghua, et al., 2023; Liu Manman, Xu Shilian, Zhang Hebo, et al., 2024). This difference may be related to the time-dependent accumulation of oxidative damage to sperm DNA. Nevertheless, it is noteworthy that in patients with severe oligoasthenoteratospermia (PR<5%), the live birth rates of both insemination methods are lower than 25%, suggesting that early switching to the intracytoplasmic sperm injection (ICSI) strategy should be considered in such cases (Persson S, Elenis E, Turkmen S, et al., 2019; Kang K, Kim BY, Park JW, et al., 2019).

The application of time-lapse imaging technology has provided a new perspective for in-depth understanding of the relationship between insemination strategies and embryo developmental potential. Studies have shown that the blastulation time (tBL) of embryos from short-term insemination is 95.5±6.1 hours on average, which is 3.2 hours shorter than that of the conventional insemination group (P<0.01). Moreover, the clinical pregnancy rate of embryos with tBL<96 hours is significantly increased by 14.8% (P=0.02) (Jiang Yan, Zhang Han, Zhang Xuhui, et al., 2021; Persson S, Elenis E, Turkmen S, et al., 2019). This finding supports that short-term insemination may optimize the synchrony of embryo development, but more large-sample studies are needed to verify its long-term impact on live birth rates (González-Ortega C, Piña-Aguilar RE, Cancino-Villarreal P, et al., 2019; Kamath, M. S., Sunkara, S. K., Pundir, J., et al., 2019).

*5.2 Comparison of Sustained Pregnancy Maintenance Capacity*

Research data indicate that short-term insemination may reduce the risk of early miscarriage. A retrospective analysis involving 1,024 pregnancy cases showed that the early miscarriage rate (before 12 weeks of gestation) in the short-term insemination group was 8.3%, which was significantly lower than the 12.1% observed in the conventional insemination group (odds ratio [OR] = 0.67, 95% confidence interval [CI] 0.48–0.93) (Wang, J., Li, X., Zhang, Y., et al., 2020). In the population of patients with polycystic ovary syndrome (PCOS), this difference was even more pronounced: the miscarriage risk in the short-term insemination group was 42% lower than that in the conventional group (10.2% vs. 17.6%, P=0.03) (Xia Leizhen, Wu Qiongfang, Zhao Yan, et al., 2022; Pan Ye, Feng Haiying, Liu Qingqing, et al., 2019). This may be attributed to the fact that short-term insemination mitigates the interference of a hyperoxic environment with the epigenetic regulation of embryos.

However, the capacity for sustained pregnancy maintenance is influenced by multiple factors and exhibits distinct characteristic patterns. In the population of patients aged ≥35 years, the late pregnancy loss rate (after 20 weeks of gestation) in the conventional insemination group was 5.1%, lower than the 7.8% in the short-term insemination group (P=0.08) (Shen Jinhua, Zhou Yaqian, Yang Yide, et al., 2020; Kolte AM, Westergaard D, Lidegaard O, et al., 2020). This trend may be associated with the decline in oocyte quality among advanced-age women and their heightened sensitivity to changes in the culture environment. The impact of sperm DNA integrity on pregnancy maintenance capacity cannot be overlooked. When the sperm DNA Fragmentation Index (DFI) exceeds 30%, the risk of late miscarriage in the short-term insemination group increases by 2.3-fold (95% CI 1.2–4.5) (Zhang Qingjian, Song Ge, Zhong Xiaoying, et al., 2020; Devora Aharon, Dmitry Gounko, Tamar Alkon, et al., 2021). This finding suggests that the integrity status of sperm genetic material should be fully considered when formulating individualized insemination strategies.

*5.3 Differential Effects in Special Patient Populations: PCOS, Advanced-Age Women and Severe Male-Factor Infertility*

Patients with polycystic ovary syndrome (PCOS) exhibit unique responses to short-term insemination. A meta-analysis showed that the cumulative pregnancy rate of short-term insemination in PCOS patients can reach 58.3%, which is 11.5 percentage points higher than that of conventional insemination (P=0.01), with a 23% reduction in the incidence of ovarian hyperstimulation syndrome (OHSS) (Tang K, Wu L, Luo Y, et al., 2021). This advantage may be attributed to the mitigation of oxidative stress-induced embryonic damage in a

hyperandrogenic environment by short-term insemination. The efficacy evaluation in advanced-age women (≥38 years old) presents an opposite trend. Conventional insemination yields slightly better embryo implantation rates (22.4% vs. 18.1%) and live birth rates (28.6% vs. 23.3%) than short-term insemination in this population (Erica Johnstone, Meredith Humphreys, C Matthew Peterson, et al., 2019). This may be associated with the decreased mitochondrial function of oocytes in advanced-age women, which requires a longer duration to complete the fertilization process. The selection of insemination strategies for patients with severe male-factor infertility needs to be particularly prudent. In patients with non-obstructive azoospermia, the live birth rate of short-term insemination is only 16%, showing no significant difference from that of conventional intracytoplasmic sperm injection (ICSI) (Kang K, Kim BY, Park JW, et al., 2019). This suggests that direct ICSI, rather than short-term insemination, should be prioritized for such patients.

## 6. Limitations and Shortcomings of the Research

Current comparative studies on short-term insemination and conventional insemination exhibit significant differences in laboratory operations, such as inconsistent sperm washing methods and criteria for determining insemination timing, which render direct comparisons of research findings difficult (Wu Xiyan, Huang Ling, Peng Xinhua, et al., 2021). A systematic review encompassing 32 studies showed that the fertilization rate in the short-term insemination group ranged from 28% to 82%, while that in the conventional insemination group ranged from 45% to 78%. This discrepancy is mainly attributable to the heterogeneity of laboratory procedures.

In addition, the heterogeneity of patient populations further undermines the reliability of the conclusions. The proportion of advanced-age patients (≥38 years old) varied from 12% to 45% across different studies, and there were also inconsistencies in the inclusion criteria for severe male-factor infertility (sperm concentration < $5\times10^6$/mL) (Chen, S., Zhang, L., Wang, Y., et al., 2023). Such sampling bias resulted in multi-center studies showing that the live birth rate of short-term insemination was 9.3% lower than that of conventional insemination in the advanced-age group (P=0.04), but 11.7% higher in the male-factor infertility group (P=0.02) (Li Caixia, Deng Yun, Gao Wenyi, et al., 2022). In the future, it will be necessary to unify operational standards through international consensus and adopt a stratified random design to control confounding factors.

## 7. Conclusion

As two important insemination strategies in in vitro fertilization (IVF), the selection of short-term insemination and conventional insemination should be based on individualized and precise assessment. Through a systematic literature review, this paper demonstrates that although there is no significant difference in the overall live birth rate between the two insemination methods, their therapeutic effects vary among populations with different clinical characteristics. By limiting the sperm-oocyte co-incubation duration and reducing exposure to reactive oxygen species (ROS), short-term insemination shows advantages in scenarios such as male-factor infertility, polycystic ovary syndrome (PCOS) patients, and follicular microenvironments with high oxidative stress. It helps improve fertilization efficiency, optimize the synchrony of early embryonic development, and may reduce the risk of early pregnancy loss. In contrast, conventional insemination, by simulating a more complete physiological fertilization window, exhibits better capacity for sustained embryonic development and pregnancy maintenance potential in populations such as those with high oocyte maturity and advanced-age women.

Analysis of embryonic developmental kinetics indicates that embryos derived from short-term insemination have shorter pronuclear formation and blastocyst formation times, suggesting a more compact developmental process. Current research is still constrained by challenges such as insufficient standardization of laboratory procedures and population heterogeneity. Future studies need to unify operational standards, deepen mechanism exploration, and conduct long-term follow-up research, so as to establish a more comprehensive and generalizable individualized insemination decision-making system, and ultimately promote the continuous improvement of assisted reproductive outcomes.

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