A Multidimensional Framework for Strategic Planning of Assisted Reproductive Technologies: A Systematic Review

Hui Wei[1], Sien Mo[1], Yan Fu[1], Shuai Lu[2], Nan Li[1]*, Gaosheng Su[1]*

Affiliations:
1.Guangxi Zhuang Autonomous The Region Reproductive Hospital, Nanning 530029, China
2.Health Commission of Guangxi Zhuang Autonomous Region, Nanning 530012, China
Author Contributions:
Hui Wei (1982-), Female, Associate Researcher. Research focus: Health Management. E-mail: 1461647456@qq.com
***Corresponding Authors:**
Nan Li (1984-), Male, M.D., Researcher, Master's Supervisor. Research focus: Assisted Reproductive Embryology. E-mail: 14393381@qq.com
Gaosheng Su (1967-), Male, Chief Physician. Research focus: Anesthesiology, Health administration. E-mail:sugaosheng@126.com

Abstract: The strategic development of Assisted Reproductive Technology (ART) within healthcare institutions is a complex, multidimensional challenge extending beyond clinical medicine to encompass governance, ethics, resource management, and socioeconomic equity. This systematic review synthesizes key factors influencing ART program planning and proposes a novel, comprehensive framework for guiding strategic decision-making. We identified and critically analyzed seven interconnected domains crucial for sustainable development: (1) Medical Technology and Infrastructure, (2) Ethical Governance and Legal Compliance, (3) Human Resources and Capital Allocation, (4) Patient-Centered Care and Support Systems, (5) Research Innovation and Data Management, (6) International Collaboration and Knowledge Exchange, and (7) Socioeconomic Integration and Policy Support. The proposed framework emphasizes the necessity of addressing all domains in a balanced and synergistic manner. It aims to provide a practical, evidence-based tool for policymakers, hospital administrators, and clinical leaders globally to establish, evaluate, and optimize ART services across diverse settings.

[Hui Wei, Sien Mo, Yan Fu, Shuai Lu, Nan Li, Gaosheng Su. **A Multidimensional Framework for Strategic Planning of Assisted Reproductive Technologies: A Systematic Review.** *JAm Sci* 2026;22(2):165-174]. ISSN 1545-1003 (print); ISSN 2375-7264 (online).http://www.jofamericanscience.org. 04. doi: 10.7537/marsjas220226.04

Keywords: Assisted Reproductive Technology; Strategic Planning; Health Policy; Ethics; Health Systems Framework; Systematic Review

Funding: This work was supported by the Guangxi Healthcare Appropriate Technology Development and Promotion Project (S2024127,S2023056); Guangxi Traditional Chinese Medicine Appropriate Technology Development and Promotion Project (GZSY2026072), Self-funded Research Project of the Health Commission of Guangxi Zhuang Autonomous Region (Z-A20220367, Z-A20220364, Z-A20230437,Z-A20250356); Youjiang Medical University for Nationalities Research Project (yy2025ky002).

1. Introduction

The rapid advancement and application of Assisted Reproductive Technology (ART) have established it as a strategically important component of modern healthcare systems. ART refers to medical techniques that assist with part or all of the fertilization and embryonic development processes outside the body, followed by embryo transfer into the uterus, primarily including artificial insemination, in vitro fertilization-embryo transfer, and embryo cryopreservation (1). While ART has brought hope to countless infertile families, it simultaneously faces multifaceted challenges in technology, ethics, and law (2). Planning for the sustainable and equitable development of ART services requires a holistic approach that balances innovation with responsibility, and clinical excellence with ethical and managerial rigor. Although numerous studies have examined individual aspects—such as cost-effectiveness, legal frameworks, or specific clinical outcomes—there is a lack of an integrative framework that guides the strategic planning of ART programs at the institutional and health-system levels. This study aims to fill this gap by conducting a systematic review to construct a multidimensional strategic planning framework for ART (Figure 1), providing a foundational reference for addressing the multifaceted challenges in this dynamic field.

2. Methods

To ensure a comprehensive and replicable evidence synthesis, this study adopted a systematic review methodology focusing on identifying key domains influencing ART program development. A structured search was conducted in PubMed, Web of Science, and Google Scholar for literature published between 2000 and 2024. Search terms included combinations of ("assisted reproductive technology" OR IVF) AND ("planning" OR "policy" OR "management" OR "governance" OR "ethics" OR "economics") AND ("framework" OR "model" OR "factor"). Inclusion criteria were: peer-reviewed articles, reviews, policy analyses, and major organizational reports (e.g., from WHO, ESHRE, ICMART) that explicitly discussed strategic, managerial, or policy considerations for ART service provision at the institutional or system level. Articles focusing solely on narrow clinical techniques without a broader planning context were excluded. A thematic analysis of identified literature was performed to extract recurring key factors, which were then synthesized, categorized, and logically organized into the interdependent domains constituting the proposed framework.

3. The Multidimensional Framework: Key Domains and Their Interlinkages

3.1 Medical Technology and Infrastructure: The Clinical Cornerstone

The level of medical technology and the condition of equipment are fundamental to ensuring the safe and effective delivery of ART. Development planning should be forward-looking, introducing advanced technologies such as gene editing, artificial wombs, and oocyte cryopreservation to continuously enhance ART success rates and safety (3). While technologies like CRISPR/Cas9 gene editing hold promise for curing certain genetic diseases by precisely editing embryonic genomes, concerns about off-target effects necessitate cautious clinical application, with their rapid translational potential underscores the urgency for prudent governance (4). The development of technologies like artificial wombs and oocyte cryopreservation requires further optimization, and their long-term impacts on maternal and infant health need evaluation. Planning must proactively assess the maturity, cost-effectiveness, and potentially disruptive effects of such technologies on existing ART service models, preparing accordingly through technology reserves and talent development.

Concurrently, increased financial investment is required to equip laboratories with high-precision instruments—such as real-time live-cell imaging systems, advanced oocyte incubators, and embryo monitoring systems—to provide hardware support for technological innovation. Real-time live-cell imaging allows continuous monitoring of embryonic development, enabling timely anomaly detection and improving embryo selection accuracy. Novel incubators can simulate the in vivo microenvironment to enhance in vitro maturation and fertilization rates. Integrated, intelligent embryo monitoring systems facilitate unattended culture, reducing human factor interference. Furthermore, the application of artificial intelligence in embryo assessment and cycle prediction is emerging as a new technological frontier (5). Standardizing operating procedures, establishing quality control systems, and strengthening laboratory management are also critical for ensuring medical quality. A traceable, full-process quality control system must be implemented to rigorously manage key steps such as gamete retrieval, embryo culture, and embryo transfer, thereby minimizing medical risks (6).

3.2 Ethical Governance and Legal Compliance: Defining Boundaries

While ART brings hope to families, it also raises a series of ethical controversies, including the moral status of the embryo, the legality of surrogacy, and the permissible limits of gene editing. Regarding embryonic moral status, one view holds that an embryo possesses full personhood from fertilization and deserves equal protection; another argues that moral status gradually increases with development, and early embryos are not equivalent to persons. Surrogacy can lead to fragmentation of motherhood, difficulties in establishing the legal parentage of surrogate children, and challenges in safeguarding surrogate mothers' interests. Gene editing, despite its medical promise, raises ethical risks such as "designer babies" the exacerbation social inequalities, prompting the international community to seek consensus on governance frameworks for heritable applications (7).

Development planning must prioritize ethical issues by establishing ethics committees, formulating ethical review systems, and defining the ethical boundaries of technology application. For instance, gene editing should be strictly limited to clinical research aimed at preventing severe genetic diseases, and prohibited for non-medical human embryo modification,with its clinical application guided by governance principles from international bodies like the World Health Organization (8). Embryo research should the principles of necessity and minimizing of harm, should proceeding only when justified by essential and legitimate purposes while minimizing damage to embryos. Surrogacy could be strictly managed within ethically permissible bounds, for example, by restricting commercial surrogacy, ensuring surrogate mothers' informed consent, and protecting the legal rights of surrogate children.

Simultaneously, legal and regulatory development must be accelerate to keep pace with technological progress, effectively standardizing medical practices, protecting the rights of patients and offspring, and providing a legal safeguard for ART development (9). Specialized legislation on assisted reproduction should be promptly enacted, providing clear stipulations on institutional qualifications, practitioner management, permissible scope of technology application, informed consent, and embryo protection. The legislative process should extensively solicit diverse

opinions to balance ethical values with practical needs. In this process, fully studying and drawing lessons from the diverse regulatory models of the international community (as contrasted in Table 1) can provide crucial references for domestic legislation. Concurrently, enforcement must be strengthened to crack down on illegal and non-compliant activities, maintaining a well-ordered industry.

3.3 Human Resources and Capital Allocation: The Execution Engine

A professional workforce and rational resource allocation are key drivers for advancing ART. Development planning should emphasize talent cultivation by establishing reproductive medicine programs in medical schools and enhancing training for in-demand specialists like reproductive endocrinologists and embryologists (10). The standardized residency training system should be improved to include reproductive medicine, enhancing residents' clinical skills. Collaboration between medical schools and ART institutions for joint talent cultivation is encouraged to provide students with more clinical practice opportunities. Furthermore, continuing education for practitioners should be strengthened through regular training on new technologies and advancements, elevating the overall competency of the workforce (11).

Regarding talent recruitment, flexible strategies such as "flexible talent recruitment mechanisms (e.g., non-resident overseas talent engagement)" can be adopted to attract high-level talent domestically and internationally. Talent evaluation and incentive mechanisms should be refined to offer competitive compensation and career development platforms for outstanding individuals. It is crucial to incentivize the return of high-level overseas talents and harness their expertise for domestic ART development (12). attention must be paid to building robust talent pipelines, fostering young and mid-career key personnel, refining career progression pathways, and enhancing the overall sustainability of the talent pool.

In resource allocation, balanced regional development must be coordinated through rational distribution to establish a collaborative ART service network between urban and rural areas and across regions,improving ART service accessibility in underdeveloped areas. Collaborative support programs, such as "twinning partnerships" and remote collaboration, can be provided to underdeveloped regions to enhance their diagnostic and treatment capacities. In resource-rich areas, high-quality resources should play a demonstrative and leading role, driving coordinated development in surrounding regions. Additionally, the advantages of the internet should be leveraged to build a nationwide telemedicine platform, facilitating the vertical flow of high-quality resources.

3.4 Patient-Centered Care and Support Systems: The Core Mission

The ultimate goal of ART is to meet patients' fertility needs. Development planning must be patient-centered, providing personalized, diversified, and high-quality services. Personalized treatment plans should be formulated based on specific patient conditions such as ovarian reserve and age. For patients with diminished ovarian reserve, ovarian reserve assessment can be used to assess ovarian function and formulate optimal medication regimens. For patients of advanced reproductive age, donor eggs or embryos may be recommended to improve pregnancy success rates. For patients with recurrent implantation failure, endometrial receptivity assessment and, if necessary, immunological therapy can be performed (13).

A comprehensive psychological counseling service system should be established to provide humanistic care for patients, alleviating their anxiety. Dedicated reproductive psychology clinics staffed by professional counselors can offer individual or group psychological support. Patients at critical junctures, such as during early pregnancy, should receive targeted psychological counseling to alleviate anxiety and depressive symptoms.

Healthcare processes should be optimized to improve service efficiency, allowing patients to streamline patients' clinical visits. A one-stop service model integrating consultation, examination, treatment, and follow-up into a continuous process can simplify visits. "Green channels" can be opened to provide priority services for special patient groups, such as women of advanced reproductive age. A robust consultation system should be established to promote multidisciplinary collaboration and enhance the efficiency of diagnosis and treatment for complex cases (14). Informed consent must be strengthened to safeguard patients' rights to information and informed choice. Standardized informed consent procedures should be developed to explain treatment options, success rates, risks, and costs in detail to patients, respecting their wishes and embodying patient autonomy.

Furthermore, an "grassroots ART service capacity" service model can be developed, utilizing digital means to provide patients with convenient and efficient pre-consultation, condition tracking, follow-up management, and other services. Mobile health applications based on platforms like WeChat Mini Programs can facilitate online consultations, appointment booking, test result inquiries, and feedback. An electronic medical record system for patients should be established to enable the interoperability of medical records for easier access. Big data analytics can be employed to integrate and mine patient data, supporting precision medicine (15).

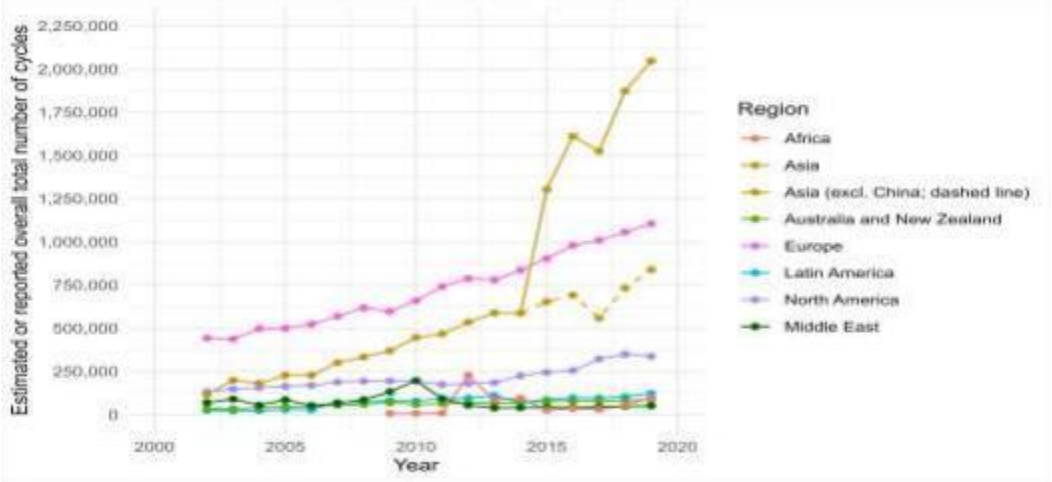
3.5 Research Innovation and Data Management: The Engine of Progress

A solid research foundation and comprehensive data support are vital for the sustainable development of ART. Development planning should increase research investment, encouraging basic research in reproductive biology,

and oocyte and embryonic development to provide theoretical underpinnings for technological advancement. Research on mechanisms of oogenesis, regulation of the follicular microenvironment, embryo implantation, etc., should be intensified to elucidate the pathogenesis of reproductive disorders and offer new insights for improving clinical strategies (16). Greater emphasis should be placed the application of novel technologies such as stem cell biology and omics in reproductive research to broaden perspectives and methodologies (17).

Translational research should be strengthened to accelerate the translation of research findings into clinical applications. Translational research on new technologies like in vitro oocyte maturation, oocyte cryopreservation, and oocyte activation for non-obstructive azoospermia should be conducted to speed up the translation from the laboratory to clinical practice. Healthcare institutions, universities, and research institutes should be encouraged to collaborate on addressing key clinical challenges, focusing on clinical needs (18).

A national-level ART database should be constructed, utilizing big data analytics to assess technological efficacy and long-term health impacts. Unified data collection standards and a nationwide ART data registration and reporting system should be established to collect data from all centers timely, accurately, and completely. Big data analytics can be used to evaluate the clinical outcomes of different protocols and identify factors influencing complications and birth defects. Continuous tracking and analysis of international ART development trends are essential, with the rapidly growing service volume (as shown in Figure 2) highlighting the urgency of strengthening data governance (19). Long-term follow-up of ART-conceived individuals should be conducted to assess their growth, development, and potential health risks (20).



Note: This figure, based on integrated data from reports by organizations such as the American Society for Reproductive Medicine (ASRM), illustrates the sustained growth trend in reported ART cycles globally. This trend graphically reflects the growth in clinical demand for ART and the expansion of its technological application, providing an important quantitative context for formulating forward-looking development plans.

Figure 2. Global Growth Trend in Assisted Reproductive Technology (ART) Treatment Cycles

The ART information registration system should be improved, and health monitoring of the individuals conceived via assisted reproductive technology strengthened to provide data support for scientific decision-making. An ART offspring birth defect monitoring network should be established to conduct regular surveys and promptly identify potential health issues. The ART information registration management measures should be refined, specifying the content, frequency, and responsible entities for registration and reporting, ensuring data authenticity and reliability. Data sharing and openness should be enhanced to provide data support for relevant departments in policymaking and research.

Simultaneously, intellectual property protection must be emphasized, academic conduct standardized, and a conducive research environment fostered. Patent applications and protection for ART-related innovations should be strengthened to safeguard the legitimate rights of R&D entities (21). Strict academic integrity norms should be established, with a "zero-tolerance" policy towards academic misconduct to uphold scholarly integrity (22). A research

culture that encourages innovation and tolerates failure should be fostered to motivate researchers' initiative and creativity (23).

3.6 International Collaboration and Knowledge Exchange: A Catalyst for Development

International collaboration and exchange in ART facilitates the introduction of advanced technologies, allowing for the adoption of successful experiences from other countries, and enhance the overall level of domestic practice. Development planning should adopt a more open and inclusive strategy to strengthen international cooperation in talent recruitment, technology introduce, and joint R&D (24).

Regarding talent recruitment, more flexible policies should be formulated to allow overseas high-level talents to participate in domestic ART development through flexible working arrangements, project cooperation, and other means. Talent evaluation criteria should berefined to incorporate overseas work experience and research achievements. An international talent database should be established to maintain connections with overseas high-level talents, supporting flexible recruitment. Concurrently, domestic ART professionals should be encouraged to go abroad for training at renowned international institutions to enhance their globalperspectives and competencies.

A sound mechanism for technology introduction should be established to keep abreast of international technological advancements and selectively adopt advanced technologies appropriate for the national context. An expert committee for introduction can be formed to conduct feasibility studies and risk assessments for proposed technologies. Technical exchange and cooperation with foreign ART institutions should bestrengthened through expert lectures, technical training, etc., to mastercutting-edge technologies. For introduced key technologies and core equipment, absorption, adaptation, and re-innovation are essential to develop independent intellectual property.

In joint R&D, China's advantages ofa large population base and rich case resources should be leveraged to actively engage in international scientific cooperation. Support should be provided for domestic ART institutions to collaborate with renowned international medical and research institutions on joint research in frontier fields like stem cells and gene editing. Enterprises should be encouraged to participate in international industry-academia-research cooperation to accelerate the commercialization of research outcomes. Active participation in global multi-center clinical trials is encouraged to enhance the participation and leadership of Chinese scholars in international multicenter research.

Simultaneously, active participation in activities of international ART-related organizations is crucial to enhance China’s voice and influence in international ART forums and influence. Joining more international ART academic organizations and participating in developing international guidelines and norms can help safeguard national interests. Hosting international academic conferences to build international exchange platforms showcases China's ART development achievements (25). Strengthening regional cooperation with neighboring countries to jointly address regional challenges can promote balanced development.

Furthermore, international exchange on ART policies and regulations should be strengthened to learn from foreign legislative experience and improve China's relevant laws and regulations(table1(26-34)). At the same time, policies must be grounded in national conditions, formulating laws and regulations that align with China's reality, and forging a distinctive path for ART development with Chinese characteristics based on absorption and adaptation of international experience.

In summary, strengthening international exchange and cooperation in ART is conducive to enhancing China's overall ART development level. A more open attitude should be adopted to integrate into the global ART development network, deepen pragmatic cooperation with various countries, showcase China's ART achievements on a broader platform, and contribute to the responsible development of global ART endeavors.

Table 1. Comparison of Key Regulatory Policies for Assisted Reproductive Technology (ART) Across Major Countries/Regions

Country/ Region	In Vitro Embryo Culture Duration	Gamete/Embryo Donation Rules	Legal Status of Surrogacy	Heritable Genome Editing Policy
UK	**14 days** Legally strictly restricts embryos from surviving in vitro for more than 14 days after fertilization.	**Permitted and regulated** Overseen by the Human Fertilisation and Embryology Authority (HFEA). Donors must waive legal rights and obligations to any resulting children, and commercial trade is prohibited.	**Legal with restrictions** Allows altruistic surrogacy. Surrogate mothers may receive reasonable expenses, but commercial paid surrogacy is prohibited. Parental rights must be transferred through court confirmation.	**Strictly prohibited** Laws explicitly prohibit any form of heritable genome editing, including clinical application of technologies like CRISPR.
USA	**14-day rule recommended** No unified mandatory regulations at the federal level, but most states and professional guidelines (e.g., ASRM) recommend compliance.	**Highly decentralized** No unified federal law; determined by individual states. Some states (e.g., California) have detailed regulations, but generally permit gamete/embryo donation, emphasizing anonymity and informed consent.	**Significant interstate variations** Legality depends on the state: - Surrogacy-friendly states (e.g., California, Illinois): Surrogacy is legal and protected. - Restrictive states (e.g., Michigan): Surrogacy is considered illegal or unrecognized.	**Strictly restricted at federal level** The U.S. FDA prohibits clinical modification of human embryos using genome editing technologies. While research is explored, clinical application is considered illegal.
Japan	**14 days** Follows international mainstream ethical standards.	**Permitted with restrictions** Allows use of donated gametes or embryos, but no clear laws on commercial transactions. Mainly regulated through institutional ethics reviews.	**Strictly prohibited** Although not explicitly listed in laws, commercial surrogacy is explicitly prohibited under medical association guidelines and regulations, with strong social ethical opposition.	**Highly conservative** Strictly prohibits the use of such technologies for clinical reproductive purposes, allowing only basic research.
China	**Strictly adheres to the 14-day rule** Laws explicitly stipulate that in vitro culture time shall not exceed 14 days.	**Strictly prohibits commercial trade** The "Measures for the Administration of Human Assisted Reproductive Technology" explicitly prohibits the sale of gametes, embryos, and related services, emphasizing the principle of non-commercialization.	**Strictly prohibited** The "Measures for the Administration of Human Assisted Reproductive Technology" explicitly prohibits all forms of surrogacy (commercial or altruistic), with administrative penalties for violations.	**Strictly prohibited** Explicitly prohibits any form of heritable genome editing, particularly for clinical applications.

Note: This table compares core ethical and legal issues in the ART field—including the permitted duration of in vitro embryo culture, rules for gamete/embryo donation, legal status of surrogacy, and policies on the clinical application of heritable genome editing—in the United Kingdom, the United States (federal and state levels), Japan, and China. While these countries share highly similar scientific and technological foundations, their regulatory frameworks are

deeply influenced by their respective sociocultural contexts, ethical values, and legal traditions, resulting in significant diversity. For example, the UK has established a unified national regulatory system through the HFEA, whereas the US exhibits a "fragmented interstate" characteristic; China and Japan share similar stance on surrogacy (strict prohibition), but China adopts a stricter prohibition on the commercialization of gamete donation. When formulating national plans, a balance must be sought between learning from international experience and adapting to the local context.

Data Source Statement: All data in this table are derived from publicly available legal documents, government reports, and official statements from authoritative medical ethics organizations current as of 2026. Specific sources are as follows:

- *United Kingdom (UK): Primarily based on the UK Government's* Human Fertilisation and Embryology Act *and official guidance from its regulatory body, the Human Fertilisation and Embryology Authority (HFEA).*
- *United States of America (USA): Based on the U.S. Food and Drug Administration (FDA) regulatory policies on gene editing, professional guidelines from the American Society for Reproductive Medicine (ASRM), and specific legislative documents from states (e.g., California, Michigan).*
- *Japan: Based on the* Ethical Guidelines for Research on In Vitro Fertilized Embryos *issued by the Japanese Ministry of Health, Labour and Welfare, and statements from relevant medical ethics societies.*
- *China: Based on the* Administrative Measures for Human Assisted Reproductive Technology*, the* Technical Specifications for Human Assisted Reproductive Technology*, the* Ethical Principles for Human Assisted Reproductive Technology and Human Sperm Banks*, and relevant government documents issued by the National Health Commission of the People's Republic of China.*

3.7 Socioeconomic Integration and Policy Support: The Enabling Environment

The development of ART relies on societal support and economic underpinnings. Development planning should strengthen policy guidance by integrating ART into the overall plan for national economic and social development (35). Infertility prevention and treatment should be incorporated into the national public health service system, ART institution development should be included in the planning of medical institution establishment, and ART talent cultivation should be integrated into medical education development plans. Special policies promoting ART development should be formulated, offering support in areas like technology access, quality regulation, and pricing mechanisms (36).

Government investment should be increased, and public financial support policies should be refined to provide stable funding for ART development. Special development funds should be established, focusing on supporting research on key technologies, talent recruitment and cultivation, and building grassroots ART service capacity. Appropriate fiscal subsidies should be provided to public ART institutions, with priority support for resource-deficient regions. Social capital investment should be encouraged, and social donations guided to mobilize development funds through multiple channels (37).

Eligible ART treatments should be covered by health insurance to alleviate patients' financial burden (38). Economic accessibility is a critical factor influencing ART service utilization, making systematic assessment and reduction of cost barriers essential (39). Health insurance policies should be improved to establish reasonable reimbursement ratios and payment standards to address the economic burden posed by ART treatment, medication, and laboratory fees. Research indicates that insurance coverage for ART can significantly improve service accessibility. For instance, in Japan, following the implementation of ART insurance coverage in 2022, the number of patients aged 25-34 increased by 22.9%, with patient growth in rural areas significantly higher than in metropolitan regions (40). Such policy interventions not only reduce patients' financial burden but also facilitate broader access to fertility treatments.

4. Discussion

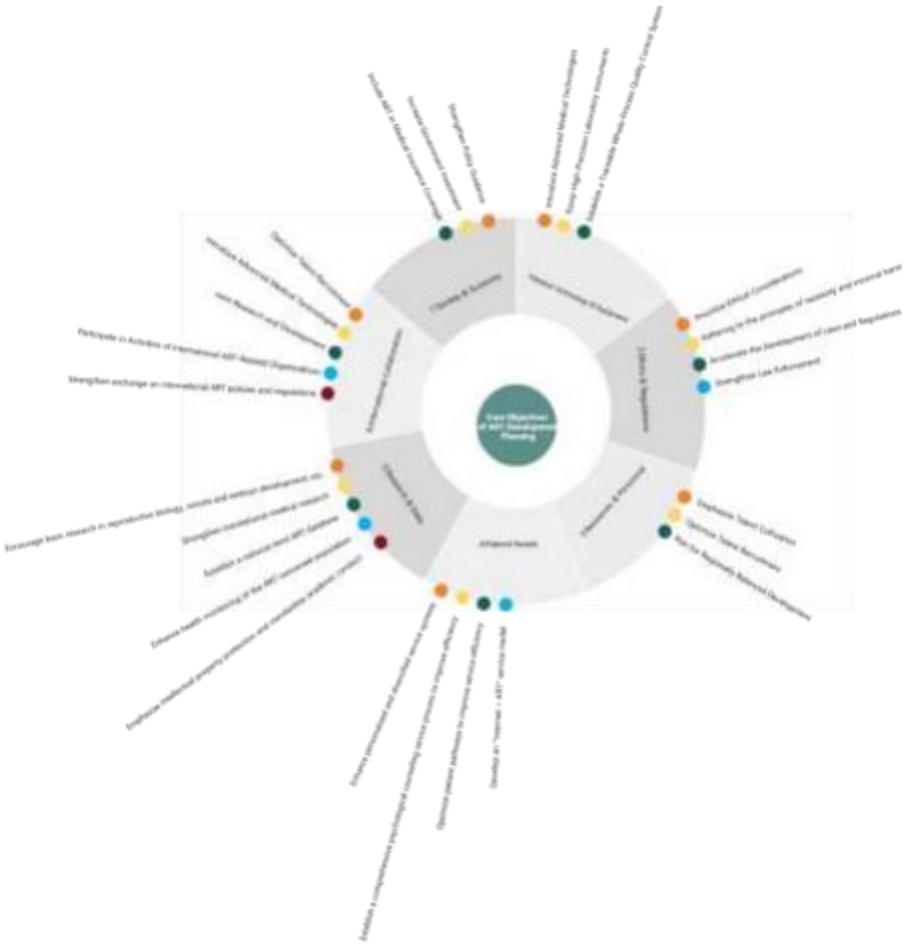
The multidimensional framework proposed in this article synthesizes scattered threads from the literature into a coherent whole, emphasizing that successful ART program development is a complex systemic challenge. Its core contribution lies in explicitly revealing the interconnections between domains often isolated in research and practice. For example, the framework illustrates how socioeconomic factors (Domain 7) directly constrain resource allocation (Domain 3) and modulate patient accessibility (Domain 4), while the ethical-legal framework (Domain 2) sets boundaries for technology application and research (Domains 1 and 5).

The framework aligns with and extends broader health systems thinking, applying health policy and management principles to the specific, high-stakes context of ART. It moves beyond a clinical checklist, offering stakeholders a structured approach to conducting situational analyses, identifying strengths and weaknesses across all key domains, and formulating balanced, resilient strategies. Future research should focus on operationalizing this framework into assessment tools and metrics and applying it in case studies across different health system contexts to

refine its utility and demonstrate its impact on program outcomes.

5. Conclusion

The development of ART services is a multifaceted endeavor requiring a comprehensive strategic vision. This systematic review proposes a multidimensional framework that identifies seven interdependent domains critical for planning: medical technology, ethical-legal governance, human and financial resources, patient-centered care, research and data, international collaboration, and socioeconomic integration. For healthcare institutions, policymakers, and funders, adopting this holistic perspective is crucial for navigating ethical tensions, managing economic realities, leveraging technological innovation, and ultimately fulfilling the core mission of providing sustainable, equitable, and high-quality reproductive care. The framework provides a foundational model to guide these complex decisions and promote the responsible development of this vital field of global assisted reproduction.



Legend: The core objective of this study is to promote the sustainable and responsible development of Assisted Reproductive Technology (ART) services. The achievement of this goal is influenced by the comprehensive governance of seven interconnected domains, necessitating their scientific coordination and

Figure 1. Multidimensional Framework for Strategic Planning of Assisted Reproductive Technology (ART) Programs in Healthcare Institutions

Acknowledgements

We thank all colleagues who participated in the discussions and provided valuable insights for this study. We also acknowledge the financial support from the aforementioned funding projects, which made the completion of this manuscript possible. for which we are grateful.

References

1. Niederberger C, Pellicer A, Cohen J, et al. Forty years of IVF. *Fertil Steril*. 2018;110(2):185-324.
2. Inhorn MC, Patrizio P. Infertility around the globe: new thinking on gender, reproductive technologies and global movements in the 21st century. *Hum Reprod Update*. 2015;21(4):411-426.
3. Vassena R, Eguizabal C, Heindryckx B, et al. Stem cells in reproductive medicine: ready for the patient? *Hum Reprod*. 2015;30(9):2014-2021.
4. Amato P, Mikhalchenko A, Mitalipov S. The case for germline gene correction: state of the science. *Fertil Steril*. 2025;124(1):22-29. doi:10.1016/j.fertnstert.2025.04.039
5. Wen L, Wu D, Ruan J, et al. Artificial intelligence-driven precision treatment of reproductive medicine-related diseases: the optimal protocol choice for IVF-ET. *JAdv Res*. Published online October 23, 2025.
6. Meseguer M, Kruhne U, Laursen S. Full in vitro fertilization laboratory mechanization: toward robotic assisted reproduction? *Fertil Steril*. 2012;97(6):1277-1286.
7. Gibelli F, Ricci G, Bailo P. Genome Editing in Medicine: A Scoping Review of Ethical, Bioethical, and Medico-Legal Implications. *JLaw Med Ethics*. Published online April 8, 2025:1-9. doi:10.1017/jme.2025.48
8. Hirakawa MP, Krishnakumar R, Timlin JA, Carney JP, Butler KS. Gene editing and CRISPR in the clinic: current and future perspectives. *Biosci Rep*. 2020;40(4). doi:10.1042/BSR20200127
9. Kaser DJ, Racowsky C. Clinical outcomes following selection of human preimplantation embryos with time-lapse monitoring: a systematic review. *Hum Reprod Update*. 2014;20(5):617-631.
10. Brezina PR, Zhao Y. The ethical, legal, and social issues impacted by modern assisted reproductive technologies. *Obstet Gynecol Int*. 2012;2012:686253.
11. Lander ES, Baylis F, Zhang F, et al. Adopt a moratorium on heritable genome editing. *Nature*. 2019;567(7747):165-168.
12. Yano K, Hayashi Y, Nakatani T. Assisted reproductive technologies and the law in Japan. *Int J Law Policy Family*. 2020;34(2):173-185.
13. Agarwal A, Majzoub A, Parekh N, et al. A Schematic Overview of the Current Status of Male Infertility Practice. *World J Mens Health*. 2020;38(3):308-322.
14. Albertini DF, Combelles CM, Benecchi E, et al. Cellular basis for paracrine regulation of ovarian follicle development. *Reproduction*. 2001;121(5):647-653.
15. Sunderam S, Kissin DM, Zhang Y, et al. Assisted Reproductive Technology Surveillance - United States, 2016. *MMWR Surveill Summ*. 2019;68(4):1-23.
16. Drakopoulos P, Blockeel C, Stoop D, et al. Conventional ovarian stimulation and single embryo transfer for IVF/ICSI. How many oocytes do we need to maximize cumulative live birth rates after utilization of all fresh and frozen embryos? *Hum Reprod*. 2016;31(2):370-376.
17. Gameiro S, Boivin J, Peronace L, et al. Why do patients discontinue fertility treatment? A systematic review of reasons and predictors of discontinuation in fertility treatment. *Hum Reprod Update*. 2012;18(6):652-669.
18. Madeira JL, Coyne K, Jaeger AS, et al. Inform and consent: more than just "sign here". *Fertil Steril*. 2017;108(1):40-41.
19. Dyer S, Chambers GM, Jwa SC, et al. International Committee for Monitoring Assisted Reproductive Technologies world report: assisted reproductive technology, 2019. *Fertil Steril*. 2025;124(4):679-693. doi:10.1016/j.fertnstert.2025.06.003
20. Aarts JW, van den Haak P, Nelen WL, et al. Patient-focused internet interventions in reproductive medicine: a scoping review. *Hum Reprod Update*. 2012;18(2):211-227.
21. Findlay JK, Hutt KJ, Hickey M, et al. What is the "ovarian reserve"? *Fertil Steril*. 2015;103(3):628-630.
22. Kushnir VA, Barad DH, Albertini DF, et al. Systematic review of worldwide trends in assisted reproductive technology 2004-2013. *Reprod Biol Endocrinol*. 2017;15(1):6.
23. Adamson GD, de Mouzon J, Chambers GM, et al. International Committee for Monitoring Assisted Reproductive Technology: world report on assisted reproductive technology, 2011. *Fertil Steril*. 2018;110(6):1067-1080.
24. De Geyter C, Calhaz-Jorge C, Kupka MS, et al. ART in Europe, 2015: results generated from European registries by ESHRE. *Hum Reprod Open*. 2020;2020(1):hoz038.
25. Korsak V, Pellicer A, Dyer S, et al. The state of ART in BRIC countries: Brazil, Russia, India and China. *J*

Reprod Biotechnol.

26. Nuffield Council on Bioethics. Nuffield Council on Bioethics to partner with UKRI Sciencewise on a public dialogue exploring the 14-day rule for human embryo research. https://www.nuffieldbioethics.org/news/nuffield-council-on-bioethics-to-partner-with-ukri-sciencewise-on-a-public-dialogue-exploring-the-14-day-rule-for-human-embryo-research. Published 2024. Accessed June 20, 2024.
27. Human Fertilisation and Embryology Authority. *Human Fertilisation and Embryology Act*. 1990. Updated 2008.
28. Olaye-Felix B, Allen DE, Metcalfe NH. Surrogacy and the law in the UK. *Postgrad Med J*. 2022. doi:10.1136/postmj/postgradmedj-2022-141625
29. Jamwal VDS, Yadav AK. The Assisted Reproductive Technology (Regulation) Act, 2021: A Step in the Right Direction. *Indian J Community Med*. 2022;48(1):4-6. doi:10.4103/ijcm.ijcm_169_22
30. Yui H, Muto K, YashiroY, et al. Survey of Japanese researchers and the public regarding the culture of human embryos in vitro beyond 14 days. *Stem Cell Reports*. 2023;18(4):799-806. doi:10.1016/j.stemcr.2023.02.005
31. Taylor G, Galichet C. *Current capabilities for human genome editing: report for the WHO Expert Advisory Committee on Developing Global Standards for Governance and Oversight of Human Genome Editing*. World Health Organization; 2021.
32. National Health Commission of the People's Republic of China. Administrative measures for human assisted reproductive technology (2001). https://www.nhc.gov.cn/wjw/c100221/202201/e61040c5c38c4b4696cdb3ee68ee27e1.shtml. Published February 20, 2001. Accessed February 3, 2026.
33. National Health Commission of the People's Republic of China. Notice on revising the technical specifications, basic standards and ethical principles related to human assisted reproductive technology and human sperm bank (2003). https://www.nhc.gov.cn/wjw/gfxwj/200309/8da11b0f3edb49cbbe5dea1dc18794a9.shtml. Published June 27, 2003. Accessed January 14, 2026.
34. Hu X, Shi J. Problems and improvements in the governance framework of human germline genome editing in China. *Business and Economic Law Review*. 2022;(1):19-37.
35. Chambers GM, Hoang VP, Sullivan EA, et al. The impact of consumer affordability on access to assisted reproductive technologies and embryo transfer practices: an international analysis. *Fertil Steril*. 2014;101(1):191-198.
36. Connolly MP, Hoorens S, Chambers GM. The costs and consequences of assisted reproductive technology: an economic perspective. *Hum Reprod Update*. 2010;16(6):603-613.
37. Jones HW Jr, Cooke I, Kempers R, et al. International Federation of Fertility Societies Surveillance 2010: preface. *Fertil Steril*. 2011;95(2):491.
38. Ferraretti AP, Nygren K, Andersen AN, et al. Trends over 15 years in ART in Europe: an analysis of 6 million cycles. *Hum Reprod Open*. 2017;2017(2):hox012.
39. Chambers GM, Hoang VP, Sullivan EA, et al. The impact of consumer affordability on access to assisted reproductive technologies and embryo transfer practices: an international analysis. *Fertil Steril*. 2014;101(1):191-198.e4. doi:10.1016/j.fertnstert.2013.09.005
40. Wada A, Yamada M, Shirasawa H, et al. Impact of insurance coverage on access to assisted reproductive technology: A nationwide survey in Japan (the IZANAMI project). *J Obstet Gynaecol Res*. 2025;51(4):e16292. doi:10.1111/jog.16292