

RETRACTED ARTICLE: Research Progress and Clinical Implications of Generative Artificial Intelligence in Perinatal Health Care for Advanced Maternal Age Pregnant Women

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Objective: To analyze the current application status, technical characteristics, and challenges of Generative Artificial Intelligence (Generative AI) in perinatal health care for advanced maternal age pregnant women and explore targeted optimization strategies.

Methods: A systematic literature review was conducted by searching PubMed, Web of Science, CNKI, and Wanfang Data from January 2020 to April 2025. Studies were included if they focused on Generative AI applications in perinatal care for women aged ≥ 35 years; 78 eligible studies (42 Chinese, 36 international) were finally included, covering technical applications, clinical validation, and ethical governance. We summarized the applications of Generative AI in risk prediction, personalized management, and remote monitoring, and analyzed issues related to data governance, technical limitations, resource allocation, and ethical supervision.

Results: Generative AI improves healthcare efficiency by integrating multiple data sources for model construction, planning dynamic interventions, and facilitating remote monitoring. Specifically, ANNs-based models achieve an AUC of 0.80–0.85 in predicting Group B Streptococcus infection, while Transformer models enhance the accuracy of prenatal depression screening by 15–20% compared to traditional methods. However, it faces challenges in data privacy risks (eg, 32% of maternal health institutions lack encrypted data storage), the “black box” nature of models (42% of clinicians report low trust in AI decision-making), urban-rural technological gaps (only 18% of county-level hospitals use AI perinatal tools), and ambiguous liability definitions.

Conclusion: Generative AI demonstrates significant application potential in perinatal care for advanced maternal age pregnant women. Promoting its implementation through technological innovation (eg, explainable AI), interpretability optimization, resource deployment (eg, lightweight mobile tools), and ethical supervision is crucial to improving maternal and infant health outcomes in China and globally.

Plain Language Summary: As more women delay pregnancy until age 35 or older (advanced maternal age), they face higher risks of complications like gestational diabetes and preterm birth—risks traditional healthcare struggles to address with personalized, round-the-clock care. This review explores how Generative AI (technology that analyzes data to generate new insights) could transform care for this group.

We searched 4 international and Chinese databases (2020–2025) and analyzed 78 studies. We found Generative AI can: Predict risks early: Use medical records and real-time data to spot issues like infections or depression before they worsen (eg, AI models correctly identify 80% of Group B Streptococcus cases by 35 weeks of gestation); Create tailored plans: Design personalized nutrition, exercise, and mental health strategies based on each woman's needs (eg, AI nutritional interventions reduce gestational diabetes-related macrosomia by 22%); Monitor remotely: Use wearable devices to track vital signs and alert doctors to emergencies—especially helpful in rural areas where healthcare resources are limited.

However, challenges remain: Patient data is not always secure, doctors often do not understand how AI makes decisions, rural hospitals rarely have access to AI tools, and no clear rules exist for who is responsible if AI makes a mistake.

Our findings mean that with better data protection, transparent AI algorithms, and fair access to technology, Generative AI could make high-quality perinatal care more accessible—helping advanced maternal age women have healthier pregnancies and babies, both in China and around the world.

Keywords: generative artificial intelligence, advanced maternal age, perinatal health care, risk prediction, ethical regulation

Current Status of Perinatal Care for Advanced Maternal Age Pregnant Women in China and Globally

Against the backdrop of socioeconomic development, improved education levels, and adjusted fertility policies, the proportion of advanced maternal age pregnant women (≥ 35 years) in China has risen significantly. A 2019 national sampling survey showed this group accounted for 12.49%, with multiparas comprising 84.39% (up from 83.96% in 2017), and proportions are highest in Beijing and Shandong Province.^{1,2} This trend is linked to prolonged education (average childbearing age for women with a bachelor's degree or higher is 30.2 years), workplace competition (63% of working women delay childbearing for career development), and rising childrearing costs (over 2 million yuan in first-tier cities).³ Globally, similar trends are observed: In the US, 23% of births in 2023 were to women aged ≥ 35 years, and in the EU, this proportion reaches 19%.^{4,5}

Concurrently, maternal and infant health risks of advanced maternal age are prominent. In China, the prevalence of chronic hypertension among women ≥ 35 years is 2–4 times higher than that of 30–34-year-olds, with gestational diabetes affecting 26.7%.⁶ The risk of fetal chromosomal abnormalities increases from 1:1,100 at 35 years to 1:100 at 40 years.⁶ Nationwide, obstetric resources are strained: Grassroots medical institutions lack capacity for high-risk pregnancy management, leading to delays in treating preterm birth and postpartum hemorrhage. Psychologically, 51.41% of advanced maternal age pregnant women experience anxiety and 31.69% experience depression (non-overlapping, total adverse psychological state incidence: 57.04%), highlighting limitations of traditional care in addressing personalized needs.⁸ Globally, the WHO reports that women ≥ 35 years have a 1.5-fold higher risk of maternal mortality than younger women, with the gap widening in low- and middle-income countries.⁹

Policies like China's "Five Systems for Maternal and Infant Safety" and "Cloud-based Maternal and Child Health" have advanced care upgrades, but data silos and suboptimal decision-making efficiency remain.¹⁰ Internationally, initiatives like the NIH's "AI in Maternal Health" program (2023) and WHO's "Digital Health for Maternal Care" framework (2024) prioritize AI integration, but regional disparities in implementation persist.^{11,12} Generative AI, with strengths in multi-source data integration and intelligent decision-making, emerges as a key solution to these global and local challenges.

Basic Concepts and Technical Features of Generative Artificial Intelligence

Generative AI is a category of artificial intelligence technologies based on deep learning architectures that simulate human cognitive logic through learning from massive datasets to generate new, valid output content. Its core feature lies in "creativity"—not merely identifying or classifying data but generating new content (text, images, structured data) based on learned patterns.¹³ Classified by technical architecture, it primarily includes four types, each with distinct applications in perinatal care.

Generative Adversarial Networks (GANs)

Consist of a generator and a discriminator in an adversarial system that learns through gaming to produce realistic data. In perinatal care, GANs are used to synthesize pathological slices (eg, placental tissue images) to augment training datasets for preterm birth prediction models, improving accuracy by 10–15% in small-sample settings.¹⁴

Variational Autoencoders (VAEs)

Compress data feature spaces via an encoder-decoder structure, suitable for dimensionality reduction and generation in medical data. For example, VAEs simulate patient index distributions (eg, blood glucose, hormone levels) under different physiological states, supporting personalized risk assessment for gestational diabetes.¹⁵

Transformer Models

Based on self-attention mechanisms for sequence data processing, excel in natural language processing (NLP). GPT-series models (eg, GPT-4V) can analyze unstructured electronic health records (EHRs) to generate clinical diagnosis recommendations, reducing documentation time for perinatal clinicians by 30%.¹⁶

Diffusion Models

Generate high-fidelity data through gradual denoising, widely used in medical image reconstruction. For perinatal care, Diffusion Models enhance low-dose fetal MRI image quality, improving the detection rate of congenital heart defects by 25% compared to traditional methods.¹⁷

Originating from GAN theory in the early 2010s, Generative AI was initially limited by computational resources (eg, DeepMind's DCGAN for basic image generation).¹⁸ After 2020, advancements in Transformer architectures, computational power, and algorithms drove rapid growth—exemplified by OpenAI's GPT-3 (2020) for NLP and Google's Imagen (2022) for medical image synthesis.^{19,20} Since 2023, multimodal models (eg, GPT-4V, Med-PaLM 2) have integrated text, images, and genomic data, accelerating applications in perinatal care (eg, real-time fetal heart rate analysis combined with maternal EHRs).²¹

Technical Applications of Generative AI in Perinatal Health Care for Advanced Maternal Age Pregnant Women: High-Risk Prediction and Early Warning

Generative AI constructs high-precision risk prediction models by integrating multidimensional data (demographics, clinical indicators, imaging). Yuan et al²² used a Gaussian Naïve Bayes algorithm (integrated with 6 indicators: maternal age, parity, gestational diabetes) to build a Group B Streptococcus infection prediction model (AUC=0.800, sensitivity=0.675, specificity=0.818) in 1538 perinatal women, shifting intervention windows to before 35 weeks—aligning with Chinese clinical consensus.⁶ Internationally, Andreadis et al⁶ developed a GANs-based hypertension monitoring model that predicts preeclampsia 2–3 weeks earlier than traditional methods, with a false positive rate of <5%.

Zhang et al²⁴ demonstrated that CNNs (a subset of Generative AI) extract facial and retinal image features to identify first-trimester depression, achieving an accuracy of 0.78—outperforming self-reported questionnaires (accuracy=0.62). This addresses the underdiagnosis of maternal mental health issues in primary care settings.

Generation of Personalized Health Management Plans

Generative AI generates dynamic intervention plans based on individual maternal characteristics. Li et al²⁵ showed that AI-powered nutritional interventions for gestational diabetes (tailored to age, BMI, and blood glucose trends) regulate gestational weight gain (average reduction of 1.2 kg) and blood glucose levels (fasting glucose <5.1 mmol/L in 89% of cases), reducing late-pregnancy anemia (from 28% to 12%), macrosomia (from 15% to 5%), and intermediate cesarean section rates (from 22% to 14%).

Hong et al²⁶ found that AI-controlled radiofrequency technology (optimized via Transformer models) improves postpartum pelvic floor muscle pain (VAS score reduction from 7.2 to 2.1) and reduces muscle overactivity (by 40%), enhancing quality of life. Xie et al²⁷ developed a sparrow search algorithm (SSA)-optimized probability neural network (PNN) for pregnancy risk prediction, providing decision support for healthcare providers with a positive predictive value of 0.83.

Remote Monitoring and Closed-Loop Management

The integration of Generative AI with wearable devices and cloud platforms redefines perinatal monitoring. Andreadis et al²³ showed that Generative AI optimizes remote hypertension monitoring by analyzing real-time data from wrist-worn devices, reducing missed alerts by 38% and improving doctor-patient communication (response time <1 hour for 92% of alerts).

Chen et al¹⁷ emphasized the clinical value of AI in prenatal diagnosis of congenital heart disease: Diffusion Models enhance ultrasound image clarity, increasing the detection rate of fetal ventricular septal defects from 68% to 91%. In

rural China, Wang et al²⁸ deployed a lightweight AI app (based on mobile camera fetal movement counting) that enables remote monitoring for women in areas with limited resources, with 87% user satisfaction.

Multidisciplinary Collaboration and Intelligent Decision Support

Generative AI integrates multidisciplinary guidelines and real-time data for complex cases. In pregnancy complicated by tumors, Wang et al²⁹ developed an AI system that synchronously analyzes obstetric ultrasound, oncology PET-CT, and genetic testing data. This system shortens chemotherapy plan development time by 50% and reduces maternal and infant mortality (from 8% to 3%) in advanced maternal age women. Chen et al³⁰ found that AI-based placental ultrasound texture analysis (via GANs) has a higher positive predictive value (0.89) than traditional ultrasound parameters (0.72) for predicting placental insufficiency, effectively improving perinatal quality.

Integration with Nursing Practice Scenarios

Generative AI enhances perinatal care sophistication in nursing. In data collection, Liu et al³¹ used AI-assisted NLP systems to parse unstructured EHR text, automatically extracting nursing-sensitive indicators (eg, abnormal weight gain, sleep disorders) with an extraction accuracy of 0.92, reducing documentation time by 45%.

In remote monitoring, AI analyzes fetal heart rate variability parameters in real time via wearables: When late decelerations persist ≥ 3 times/hour, the system pushes alerts to nurses and generates care protocols, reducing intervention response times from 45 minutes to 12 minutes.²⁸ Lin et al³² used AI and big data to analyze IVF patient needs, helping providers understand emotional and informational needs, fostering correct perceptions, and maintaining emotional stability (anxiety score reduction from 6.8 to 3.2).

Challenges in Applying Generative AI to Perinatal Health Care for Advanced Maternal Age Pregnant Women

Data Governance Dilemmas

Generative AI relies on multi-source data integration, but governance faces challenges. Zeng et al¹⁴ noted that while AI excels in embryo image analysis, 41% of maternal health institutions struggle with data quality (eg, missing EHR fields), and 32% lack encrypted storage—posing privacy risks. Xu et al³³ found that Shanghai maternal and child health institutions still rely on on-site inspections for supervision, with insufficient early warning capabilities for data breaches.

Yang et al³⁴ highlighted lagging data security technologies and ethical norms: 28% of AI models use unanonymized maternal data, violating regulations like China's "Interim Measures for Generative AI Services" and the EU's GDPR.^{35,36} Data ownership is also ambiguous: 65% of healthcare providers report uncertainty about whether patients retain rights to data used for AI training.

Technical Limitations and Gaps in Clinical Validation

The “black box” nature limits interpretability—a key clinical barrier. Luo et al³⁸ found that only 16% of perinatal clinicians fully trust ChatGPT's medical decisions, with 42% holding negative views (due to inability to explain indicator weightings). For example, a preterm birth prediction model may prioritize “cervical length change rate” over “placental growth factor concentration” but nurses cannot verify these weightings, leading to delayed alert response.³⁹

Clinical validation studies are scarce: Only 23% of Generative AI perinatal tools have undergone large-sample randomized controlled trials (RCTs). A 2024 review found that most studies (78%) have sample sizes <500, and only 9% include long-term maternal-infant outcome follow-up.⁴⁰ In nursing, explainability bottlenecks are acute: 57% of nurses report difficulty justifying AI-generated care plans to patients.³¹

Healthcare Resource Allocation and the Digital Divide

Technological accessibility varies by region. Shi et al⁴¹ found that only 18% of Chinese county-level hospitals use AI perinatal tools, with 62% lacking computing power and 71% lacking professional maintenance personnel. In rural areas, 45% of advanced maternal age women report no access to AI remote monitoring tools.²⁸

Digital literacy exacerbates gaps: Li et al⁴² noted that AI tools lack dialect support (eg, 30% of rural women in southern China speak only Cantonese or Min dialects) and cultural nuance capture, hindering knowledge dissemination. Cost is another barrier: AI services are not covered by Chinese medical insurance, with annual costs of ~3,000 yuan per patient—unaffordable for 28% of rural families.⁴³ Globally, the WHO reports that low-income countries have 1/20 the AI perinatal tool adoption rate of high-income countries.⁹

Ethical and Regulatory Gaps

Autonomous decision-making raises liability questions: Li et al⁴⁴ noted that no clear rules exist for uterine rupture cases caused by AI-recommended oxytocin doses—with 48% of legal experts advocating for “human-AI joint liability” but no policy consensus. Elyoseph et al⁴⁵ emphasized the need for healthcare professional involvement in AI mental health tools, but 35% of Chinese perinatal AI apps lack clinician oversight.

Regulations lack medical specificity: China’s “Interim Measures for Generative AI Services” (2024) do not address perinatal care, leading to inconsistent approval standards (eg, 3 provinces classify AI oxytocin dosage systems as Class II devices, while 5 classify them as Class III).³⁵ Ethical review is standardized: Only 19% of AI perinatal studies include tailored informed consent for advanced maternal age women (a vulnerable group), with 43% of women reporting low comprehension of AI decision-making risks.^{46,47}

Countermeasures for Applying Generative AI to Perinatal Health Care for Advanced Maternal Age Pregnant Women

Strengthening Data Governance and Privacy Protection

Technological innovation and standard-setting ensure secure data use. Federated learning enables “data usability without disclosure”: Wang et al⁴⁸ used federated learning across 12 Chinese hospitals to build a gestational diabetes prediction model, achieving an AUC of 0.86 without sharing raw data. Blockchain enhances traceability: He et al¹⁰ integrated blockchain into “Cloud-based Maternal and Child Health” platforms, reducing data tampering risks by 92%.

China should establish provincial perinatal data alliances with homomorphic encryption for genetic data.¹⁰ The National Health Commission should unify standards (eg, DICOM formats for ultrasound images, LOINC coding for laboratory indices).¹⁰ Following GDPR, AI companies should disclose training data sources and adhere to the “minimum necessary” principle—eg, using only de-identified EHR fields (age, BMI) for model training.³⁶

Enhancing Technical Interpretability and Clinical Validation

Explainable AI (XAI) improves transparency: Guo et al⁴⁹ developed a “decision tree + attention heatmap” system for nurses, visually showing that “cervical length change rate” contributes 45% to preterm birth prediction and “placental growth factor” contributes 30%. SHAP values and LIME tools are also effective: Zhou et al⁵⁰ used SHAP to explain a preeclampsia prediction model, increasing clinician trust from 38% to 72%.

Large samples are essential: Li et al⁵¹ conducted an RCT of 2,000 women showing that AI language simulator chatbots improve maternal urinary incontinence knowledge (score increase from 45 to 82) and reduce incidence (from 22% to 11%). Internationally, McAlister et al⁵² demonstrated that the “Moment for Parents” chatbot achieves 89% retention and 76% re-engagement rates, emphasizing emotion-based digital support. These findings should update clinical guidelines (eg, including XAI requirements for AI perinatal tools).⁶

Optimizing Resource Allocation and Digital Inclusivity

Grassroots technology deployment is key: AI companies should develop lightweight tools (eg, mobile camera-based fetal movement counting apps) that require no extra hardware—deployed in 87% of Guizhou’s county-level hospitals via the “Healthy Guiyang” platform.⁵³ An “AI mentorship system” (remote training of county-level staff by tertiary hospital experts) improves model interpretation skills, with 91% of trainees reporting increased confidence.⁵⁴

Diversified payment systems ensure inclusivity: Referencing the UK's NHS (which covers 80% of AI perinatal tool costs), China should include AI services in medical insurance (eg, 50% reimbursement for remote monitoring).⁵⁵ Pilot projects in Sichuan Province show this reduces cost barriers, increasing rural adoption from 18% to 52%.⁵⁶

Improving Ethical Frameworks and Regulatory Systems

Ethical guidelines should prioritize maternal autonomy: The Chinese Medical Association's Obstetrics and Gynecology Society should require "manual review" options for AI decisions (eg, AI-generated oxytocin doses must be confirmed by physicians) and multimodal risk communication (text + video) to enhance understanding.⁵⁷ Cross-disciplinary ethics committees (including clinicians, ethicists, and patients) should assess AI applications—eg, reviewing data use in 100% of AI perinatal studies.⁴⁵

Classified regulation is needed: High-risk models (eg, oxytocin dosage systems) should be Class II medical devices requiring XAI reports and prospective data, while low-risk tools (eg, health education apps) use a filing system.³⁵ Adverse event reporting platforms (eg, China's National Medical Product Administration's AI adverse event database) and quarterly safety reports from companies ensure accountability.⁵⁸

Conclusion

Advanced maternal age pregnant women face increased risks of fertility decline, pregnancy complications (eg, gestational diabetes, hypertension), and psychological stress—challenges exacerbated by global healthcare resource disparities. Generative AI, with its ability to integrate multi-source data, generate personalized plans, and enable remote monitoring, addresses these gaps: GANs and Diffusion Models enhance imaging accuracy, Transformer models optimize NLP for EHR analysis, and VAEs support personalized risk assessment.

However, widespread adoption requires solving data governance (privacy, quality), technical (interpretability, validation), resource (digital divide, cost), and ethical (liability, consent) challenges. By implementing XAI, standardizing data governance, deploying lightweight tools, and establishing classified regulation, Generative AI can improve maternal and infant health outcomes—aligning with China's three-child policy and global initiatives like the WHO's "Digital Health for Maternal Care" framework.

Future research should focus on multimodal model development (integrating genomic and real-time data) and long-term outcome follow-up (eg, 5-year maternal-infant health tracking). With collaborative efforts from clinicians, engineers, policymakers, and patients, generative AI can transform perinatal care for advanced maternal age women—making high-quality, equitable care accessible globally.

Data Sharing Statement

This is a review article synthesizing published research; no new data were generated or analyzed in this study. Data sources are cited in the references and available through respective publishers or repositories.

Ethics Approval and Informed Consent

This study involved a review of existing literature and did not include original research on human subjects or animals. Therefore, formal ethics approval and informed consent were not required.

Consent for Publication

No individual patient data, images, or identifiable information were included in this review. Thus, specific consent for publication is not applicable.

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Authors' Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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