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Global Medicines Regulation in Pregnancy and Lactation: Addressing Emerging Therapies, Safety, and Access Inequalities

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ABSTRACT

Safe medication use during pregnancy and lactation is fundamental to protecting maternal and neonatal health. However, global variability in regulatory frameworks, pharmacovigilance systems, and access to therapies presents major challenges-particularly for emerging treatments such as biologics, GLP-1 receptor agonists, and novel small molecules. This review aimed to synthesize international regulatory frameworks, evaluate safety monitoring practices, and explore disparities in access to medicines for pregnant and lactating populations. A narrative review was conducted using PubMed, Embase, Scopus, Web of Science, and regulatory agency websites (FDA, EMA, Health Canada, MHLW Japan, WHO), supplemented by pharmacovigilance databases (FAERS, VigiBase, EudraVigilance). Publications in English from 2000-2025 addressing regulatory policies, safety monitoring, or access inequalities were included. Extracted data were analyzed to identify global trends, gaps, and best practices in maternal-fetal pharmacotherapy. High-income countries demonstrate mature systems, including the FDA Pregnancy and Lactation Labeling Rule, EMA risk management plans, and comprehensive pharmacovigilance infrastructures. In contrast, low- and middle-income countries (LMICs) often face fragmented regulations, limited monitoring capacity, and restricted access to innovative therapies. Global initiatives such as the World Health Organization (WHO) guidelines, the International Council for Harmonization (ICH) E11(R1) guideline, and TransCelerate programs promote harmonization, yet substantial gaps remain. Active and passive surveillance mechanisms, pregnancy registries, and real-world data enhance safety assessment for emerging therapies, while access inequalities persist due to regulatory delays, cost, and sociocultural barriers. Despite meaningful advances in high-resource settings, LMICs continue to experience major challenges in ensuring safe and equitable access to medicines. Strengthening evidence-based, harmonized regulatory frameworks, expanding pharmacovigilance coverage, and integrating real-world evidence are essential to safeguarding maternal and neonatal health. Coordinated global collaboration is imperative to achieve equitable access to innovative therapies worldwide.

Keywords: Pregnancy, Lactation, Drug Safety, Regulatory Frameworks, Pharmacovigilance, Emerging Therapies, Access Inequalities.

INTRODUCTION

Medication use during pregnancy and lactation presents a critical challenge for healthcare providers, as decisions must balance maternal health needs with fetal and neonatal safety. Physiological changes in pregnancy can alter drug pharmacokinetics, while many medications are capable of crossing the placenta and potentially interfering with embryonic or fetal development [1]. The first trimester, particularly the period of organogenesis, is the most sensitive to teratogenic effects, whereas exposure in later stages may impact fetal growth,

neurological development, or precipitate complications at birth [2]. Untreated maternal conditions, such as epilepsy, diabetes, or hypertension, may also adversely affect pregnancy outcomes, underscoring the necessity of careful medication selection rather than complete avoidance [3].

Similarly, during lactation, the transfer of drugs into breast milk introduces another dimension of risk. Although breastfeeding is strongly recommended due to its nutritional, immunological, and developmental benefits, infants-especially neonates-are highly vulnerable to medication exposure due to their immature hepatic and renal systems [4]. This increases the risk of drug accumulation and toxicity. Consequently, choosing medications with established safety profiles and minimizing infant exposure while maintaining therapeutic benefit for the mother are key principles [5].

To ensure safe prescribing practices, guidelines such as the U.S. Food and Drug Administration's Pregnancy and Lactation Labeling Rule (PLLR) provide clinicians with structured information on potential risks and evidence-based recommendations [6]. Rational use of medications during these periods requires a case-by-case assessment that prioritizes drugs with favorable safety data, uses the lowest effective dose, and avoids unnecessary exposure. Ultimately, promoting safe medication use during pregnancy and lactation is essential to optimize maternal health outcomes while safeguarding fetal and neonatal development.

Global disparities in health policy, implementation, and access significantly affect the safe use of medications and emerging therapies during pregnancy and lactation. While high-income countries often benefit from robust pharmacovigilance systems, well-established clinical guidelines, and comprehensive regulatory frameworks, many low- and middle-income countries (LMICs) face substantial challenges in ensuring equitable access to safe and effective therapies [7].Variability in regulatory standards, availability of drug safety data, and healthcare infrastructure contributes to inconsistent prescribing practices and potential risks for maternal and neonatal health outcomes [8].

Implementation gaps are also pronounced, as even when policies exist, limitations in healthcare workforce training, access to diagnostic tools, and patient education can hinder effective application [9]. For instance, biologics and GLP-1 receptor agonists may be widely available in high-resource settings but remain prohibitively expensive or inaccessible in LMICs, creating inequities in the management of chronic diseases such as autoimmune disorders, obesity, and diabetes [10]. Similarly, access to novel vaccines, as observed during the COVID-19 pandemic, highlighted global inequalities in distribution, with delayed availability in resource-limited settings disproportionately affecting pregnant women and infants [11].

Addressing these disparities requires harmonization of regulatory policies, strengthening of global pharmacovigilance networks, and strategies to enhance affordability and accessibility of essential medicines. International collaboration, investment in maternal health infrastructure, and culturally sensitive implementation programs are essential to reduce inequities and ensure that pregnant and lactating women worldwide benefit from advances in therapeutic innovation [12].

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The introduction of emerging therapies such as biologics, glucagon-like peptide-1 (GLP-1) receptor agonists, and novel vaccines has transformed the therapeutic landscape across multiple clinical domains. While these agents provide substantial benefits in the management of autoimmune disorders, metabolic diseases, and infectious threats, their use during pregnancy and lactation remains a significant challenge due to limited safety data and evolving clinical evidence [13]. Unlike conventional small-molecule drugs, biologics and peptide-based therapies have unique pharmacokinetic and immunological properties, which complicate predictions regarding placental transfer, teratogenicity, and excretion into breast milk [14].

Biologic therapies, including monoclonal antibodies, have shown remarkable efficacy in treating chronic inflammatory conditions such as rheumatoid arthritis, inflammatory bowel disease, and psoriasis. However, concerns persist regarding transplacental passage of immunoglobulin G (IgG) during the second and third trimesters, with potential implications for neonatal immune function [15]. Similarly, the growing use of GLP-1 receptor agonists in obesity and type 2 diabetes raises concerns for pregnancy management, as preclinical data suggest possible effects on fetal growth and limited human studies restrict firm conclusions [16].

The rapid development and deployment of novel vaccines, particularly during the COVID-19 pandemic, have highlighted both opportunities and challenges in maternal-fetal medicine. While vaccination in pregnancy can provide critical maternal protection and passive immunity for the neonate, questions regarding long-term safety, immunogenicity, and appropriate timing of administration continue to be debated [17]. Collectively, these challenges emphasize the need for rigorous pharmacovigilance, well-designed pregnancy registries, and evidence-based counseling to guide therapeutic decision-making for pregnant and lactating women.

The primary objective of this review is to synthesize the current global regulatory frameworks governing medication use in pregnancy and lactation, emphasizing both high-income and low- to middle-income country contexts. By examining national and international guidelines, labeling practices, risk management strategies, and harmonization initiatives, the review aims to provide a comprehensive understanding of regulatory approaches that safeguard maternal and neonatal health.

A secondary objective is to highlight safety monitoring and pharmacovigilance practices, including both active and passive surveillance systems, the use of real-world data, and pregnancy registries. This aspect emphasizes the importance of ongoing risk assessment for emerging therapies and the role of global pharmacovigilance platforms in identifying, mitigating, and communicating drug-related risks in vulnerable populations.

Finally, the review seeks to explore access inequalities, identifying disparities in regulatory enforcement, availability of pharmacovigilance infrastructure, affordability, and cultural or systemic barriers that limit safe medication use during pregnancy and lactation. By integrating these three focal areas-regulatory frameworks, safety monitoring, and access inequalities-the objectives collectively aim to inform evidence-based policy recommendations, support equitable healthcare practices, and guide clinicians, regulators, and stakeholders in optimizing the safe and effective use of medications for pregnant and lactating populations.

METHODOLOGY

This narrative review was conducted to evaluate global regulatory frameworks, safety monitoring practices, and access inequalities related to medication use during pregnancy and lactation. The aim was to synthesize evidence from regulatory guidance documents, peer-reviewed literature, pharmacovigilance reports, and international policy statements, with an emphasis on both high-income countries (HICs) and low- to middle-income countries (LMICs). Data extraction focused on identifying trends, gaps, and best practices in regulatory oversight, monitoring systems, and equitable access to emerging therapies, particularly biologics, GLP-1 receptor agonists, and novel small molecules.

Literature Search and Inclusion Criteria

A comprehensive literature search was conducted across electronic databases including PubMed, Embase, Scopus, and Web of Science. This was supplemented by targeted searches of regulatory agency websites, including the FDA, EMA, Health Canada, Japan's Ministry of Health, and the World Health Organization (WHO), as well as international pharmacovigilance platforms such as FAERS, VigiBase, and EudraVigilance. Search terms included keywords and MeSH terms related to pregnancy, lactation, drug safety, regulatory frameworks, pharmacovigilance, emerging therapies, and access inequalities. Articles and reports were included if they were published in English between 2000 and 2025 and comprised peer-reviewed original research, systematic reviews, meta-analyses, and authoritative documents from international organizations.

HISTORICAL CONTEXT

FDA Pregnancy Categories, PLLR and Key Regulatory Milestones (e.g. Thalidomide)

The history of medication use in pregnancy is shaped by pivotal regulatory milestones that emerged in response to catastrophic drug-related events. The thalidomide tragedy of the late 1950s and early 1960s, in which thousands of infants were born with severe limb malformations after maternal exposure to the drug during pregnancy, marked a turning point in global drug regulation [18]. This incident underscored the need for rigorous preclinical teratogenicity testing, systematic post-marketing surveillance, and strengthened regulatory oversight [19].

In the aftermath, the U.S. Food and Drug Administration (FDA) introduced the pregnancy risk classification system in 1979, known as the A-X categories. This framework aimed to simplify prescriber decision-making by categorizing medications based on available evidence of teratogenic risk [20]. However, over time, it became clear that the system was overly simplistic and often misinterpreted, as it failed to capture the complexity of risk–benefit assessments and the nuances of available human versus animal data [21].

To address these limitations, the FDA implemented the Pregnancy and Lactation Labeling Rule (PLLR) in 2015, which replaced the letter categories with narrative summaries that provide detailed information on risks, clinical considerations, and data quality [22]. The PLLR represents a paradigm shift toward evidence-based, patient-centered counseling, enabling healthcare providers to make more informed prescribing decisions during pregnancy and lactation [23]. These historical developments highlight the evolving nature of drug regulation, emphasizing a continuous commitment to improving maternal and fetal safety.

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Figure 1 illustrates the key regulatory agencies and their respective systems/components responsible for ensuring safe medication use during pregnancy and lactation.

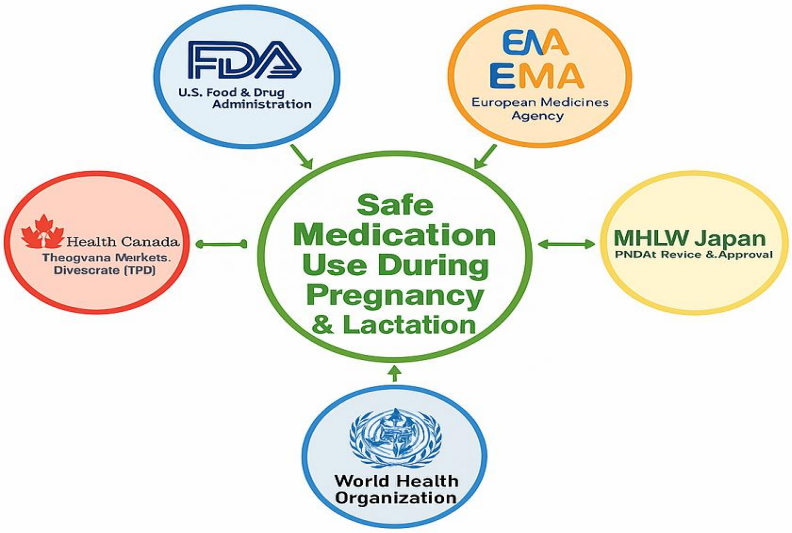

Figure 1: The key global regulatory agencies involved in the critical process of ensuring safe medication use during pregnancy and lactation

GLOBAL REGULATORY FRAMEWORKS

High-Income Countries

High-income countries (HICs) have well-established regulatory systems that aim to ensure safe medication use during pregnancy and lactation. In the United States, the FDA's Pregnancy and Lactation Labeling Rule (PLLR) provides detailed narrative labeling to inform clinical decision-making, while Risk Evaluation and Mitigation Strategies (REMS) programs manage drugs with higher potential risks [6],[8].In Europe, the European Medicines Agency (EMA) issues guidelines for maternal-fetal risk assessment, requiring risk management plans and integrating expert input from maternal-fetal medicine specialists [9]. Similarly, countries such as Japan, Canada, and Australia maintain regulatory frameworks with robust reporting systems, pharmacovigilance mandates, and guidance specific to pregnant and lactating populations[12],[24].

Low- and Middle-Income Countries (LMICs)

In contrast, LMICs often face fragmented regulatory systems with limited enforcement capacity, gaps in pre- and post-marketing safety data, and inconsistent monitoring mechanisms. Regional examples include challenges in the MENA region, Sub-Saharan Africa, and parts of Latin America, where delayed adoption of international guidelines and scarce pharmacovigilance infrastructure hinder timely detection of adverse drug events[25],[26].

Global Standards & Initiatives

Global initiatives aim to harmonize regulatory approaches. The World Health Organization (WHO) provides guidelines for medication safety in pregnancy, while the ICH E11(R1) guidance focuses on pediatric and perinatal considerations in clinical trials[27]. The TransCelerate initiative facilitates cross-industry collaboration for safety assessment and data sharing. Pharmacovigilance platforms such as the FDA Adverse Event Reporting System (FAERS), VigiBase, and EudraVigilance enable international monitoring and signal detection to support

regulatory decision-making [28]. Table 1 provide a comparative overview of five major pharmacovigilance databases-Canada's CADRMP (Canada Vigilance Program/Canada Vigilance Adverse Reaction Online Database), FAERS, VigiBase, EudraVigilance, and JADER-highlighting their scope, managing organizations, data sources, accessibility, strengths, limitations, and applications in research [29],[30],[31],[32],[33].

Table 1: Comparison of Major Pharmacovigilance Databases: Canada's CADRMP (Canada Vigilance Program/Canada Vigilance Adverse Reaction Online Database), FAERS, VigiBase, EudraVigilance, and JADER

Feature	FAERS	VigiBase	EudraVigilance	JADER	Canada Vigilance (CADRMP)
Full Name	FDA Adverse Event Reporting System	WHO Global Database of Individual Case Safety Reports (ICSRs)	European Union Drug Regulating Authorities Pharmacovigilance Database	Japanese Adverse Drug Event Report Database	Canada Vigilance Adverse Reaction Monitoring Program
Region / Scope	United States	Global (over 140 countries)	European Union (EU/EEA)	Japan	Canada
Managing Organization	U.S. Food and Drug Administration (FDA)	WHO – managed by Uppsala Monitoring Centre (UMC), Sweden	European Medicines Agency (EMA)	Pharmaceuticals and Medical Devices Agency (PMDA), Japan	Health Canada
Data Sources	Voluntary reports (patients, healthcare providers) + mandatory manufacturer reports	National pharmacovigilance centers in member states	Marketing Authorization Holders (MAHs), National Competent Authorities, HCPs, patients	Mandatory reports from MAHs, HCPs, patients	Healthcare professionals, consumers, manufacturers, and distributors
Primary Purpose	Detect and evaluate post-marketing safety signals	International pharmacovigilance collaboration and signal detection	Monitor suspected adverse reactions within EU/EEA for regulatory action	Post-marketing safety monitoring in Japan	Monitor and assess adverse drug reactions within Canada
Type of Reports	Individual Case Safety Reports (ICSRs)	ICSRs (adverse drug reactions worldwide)	ICSRs (serious and non-serious ADRs)	ICSRs (ADR and adverse event reports)	ICSRs (suspected adverse drug reactions)
Accessibility	Public dashboard + quarterly raw data downloads	Restricted; access via VigiLyze (mainly regulators/researchers)	Public ADR summary reports (EMA website); full data restricted	Public, downloadable datasets (CSV, Japanese language)	Public searchable database (Canada Vigilance Online); summary data available
Strengths	Large U.S. dataset; transparency, open access	Largest global ADR repository; global signal detection	Comprehensive EU regulatory integration	Transparency, population-specific focus	Public-friendly online search tool; Canada-wide coverage
Limitations	Underreporting, no denominator data	Restricted access; variability in country reporting	Limited public data; EU-specific focus	Language barrier; not fully global	Limited to Canada; underreporting possible

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Use in Research	Widely used in drug safety and pharmacoepidemiology	Rare ADR detection, cross-country comparisons, global signal validation	EU regulatory decision-making, signal strengthening, risk–benefit assessment	Population-specific ADR studies in Japan	National safety signal detection, supports Health Canada regulatory action

Safety Monitoring & Pharmacovigilance

Safety monitoring relies on both active and passive surveillance systems. Passive systems collect spontaneous reports of adverse events, while active surveillance uses structured approaches such as registries, electronic health records, and claims databases to identify risks systematically[34]. Real-world data is increasingly utilized to evaluate emerging therapies, enabling signal detection, risk mitigation, and ongoing assessment of maternal and neonatal outcomes[35].

LIMITATIONS OF TRADITIONAL CLINICAL TRIALS IN PREGNANT AND LACTATING POPULATIONS

Pregnant and lactating populations have historically been excluded from most clinical trials, resulting in significant gaps in evidence regarding the safety and efficacy of medications during these critical periods. Ethical concerns, liability risks, and the potential for fetal or neonatal harm have traditionally led to the systematic exclusion of these populations from randomized controlled trials (RCTs) [36],[37]. Consequently, the majority of available drug safety and efficacy data are extrapolated from studies in non-pregnant adults, animal models, or post-marketing surveillance, which may not accurately reflect maternal-fetal pharmacokinetics and pharmacodynamics [38].

Traditional clinical trial designs often fail to account for the unique physiological changes of pregnancy, such as altered plasma volume, increased renal clearance, and shifts in hepatic metabolism, all of which can substantially impact drug absorption, distribution, metabolism, and elimination [39]. Lactation introduces additional complexities, including the passage of drugs into breast milk and the immature metabolic capacity of the neonate, making it difficult to predict infant exposure and risk [24]. These limitations hinder evidence-based prescribing and can result in suboptimal maternal treatment, unrecognized fetal or neonatal toxicity, and increased healthcare disparities.

Addressing these challenges requires innovative trial designs, such as adaptive trials, physiologically based pharmacokinetic modeling, pregnancy registries, and post-marketing observational studies. Expanding the inclusion of pregnant and lactating women in research, coupled with rigorous monitoring and ethical oversight, is essential to generate robust, clinically relevant data that guide safe and effective therapy in these populations [4].

RISKS OF INADEQUATE REGULATION FOR MOTHER AND CHILD

Inadequate regulation of medications during pregnancy and lactation poses significant risks to both maternal and neonatal health. Without robust regulatory oversight, drugs may reach the market without sufficient preclinical or clinical safety data regarding teratogenicity, fetal development, or neonatal pharmacokinetics [14]. Historical tragedies, such as the thalidomide disaster, demonstrate the severe consequences of insufficient testing and post-marketing

surveillance, resulting in thousands of infants with congenital malformations and long-term disability [8]

Beyond rare catastrophic events, inconsistent regulatory standards and weak enforcement can lead to inappropriate prescribing, off-label use, or exposure to untested therapies. For mothers, this may result in poorly managed chronic conditions, adverse drug reactions, or pregnancy complications, while for infants, risks include growth restriction, congenital anomalies, neonatal toxicity, or impaired neurodevelopment [9]. Emerging therapies, such as biologics, GLP-1 receptor agonists, and novel vaccines, further underscore the importance of rigorous regulation, as limited human data make evidence-based risk assessment challenging [40].

Strengthening regulatory frameworks, harmonizing global standards, and ensuring comprehensive pharmacovigilance are essential to mitigate these risks. Such measures enable healthcare providers to make informed prescribing decisions, optimize maternal treatment, and safeguard fetal and neonatal outcomes, ultimately reducing preventable harm associated with inadequate drug regulation [12].

EMERGING THERAPIES

New Drug Classes: Biologics, Gene Therapies, Novel Small Molecules, GLP-1RAs

Table 2 highlights key drug classes (biologics, GLP-1 receptor agonists, gene therapies, novel small molecules, and vaccines), summarizing available safety data, identified risks, ongoing studies or registries, and current clinical guidance. It underscores the evidence gaps and need for registry-based and real-world data to inform clinical decision-making.

The development of emerging therapies has introduced a range of innovative drug classes that are transforming the management of chronic and complex diseases. Biologics, including monoclonal antibodies and recombinant proteins, have shown high specificity and efficacy in treating autoimmune, inflammatory, and oncologic conditions [41].Gene therapies offer the potential for curative interventions by directly targeting genetic defects, although their application during pregnancy and lactation is limited due to safety concerns and insufficient clinical data [42].

Novel small molecules continue to expand therapeutic options across multiple indications, often offering improved pharmacokinetics, bioavailability, or targeted mechanisms of action compared with traditional agents [25]. Among these, glucagon-like peptide-1 receptor agonists (GLP-1RAs) have emerged as effective treatments for type 2 diabetes and obesity, providing both glycemic control and weight reduction [14]. Despite their promise, these therapies present unique challenges in pregnant and lactating populations, including limited human safety data, potential placental transfer, and unknown long-term effects on the developing fetus or breastfeeding infant.

The rapid expansion of these drug classes underscores the need for robust pharmacovigilance, pregnancy registries, and careful risk-benefit assessment in clinical practice. Incorporating evidence from preclinical studies, real-world data, and modeling approaches can guide safe use while optimizing therapeutic outcomes for both mother and child [25].

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Table 2: Emerging Therapies and Current Evidence in Pregnancy and Lactation

Therapy Class	Known Data	Risks Identified	Ongoing Studies/Registries	Clinical Use Guidance
Biologics (mAbs)	Limited observational data	Placental transfer in 2nd/3rd trimester	Yes (multiple registries)	Cautious use, risk–benefit balance
GLP-1RAs	Sparse human data, animal studies suggest fetal growth effects	Potential fetal growth restriction	Few, ongoing	Avoid unless essential
Gene therapies	Very limited	Unknown, theoretical risks	None established	Not recommended
Novel small molecules	Some early data	Unknown teratogenicity	Limited	Case-by-case basis
Vaccines (e.g., COVID-19)	Large safety data (real-world)	No major risks identified	Yes (global)	Recommended in most settings

CURRENT EVIDENCE FOR SAFETY IN PREGNANCY AND LACTATION

The use of emerging therapies-including biologics, gene therapies, GLP-1 receptor agonists (GLP-1RAs), and novel small molecules-during pregnancy and lactation remains a significant clinical challenge due to limited safety data. Current evidence largely derived from observational studies, pregnancy registries, case reports, and post-marketing surveillance rather than randomized controlled trials, reflecting the historical exclusion of pregnant and breastfeeding women from clinical trials [41],[25].

For biologics, studies suggest that monoclonal antibodies targeting inflammatory pathways may have minimal teratogenic risk when used during the first trimester, although placental transfer increases in later trimesters, potentially affecting neonatal immune function [37].Evidence for GLP-1RAs is more limited, with animal studies indicating potential effects on fetal growth, and human data remain sparse, restricting firm conclusions regarding their safety [38].Novel small molecules and gene therapies are similarly constrained by insufficient human pregnancy data, necessitating cautious use and individualized risk–benefit assessments [14].

Despite these limitations, pregnancy registries and real-world pharmacovigilance have provided valuable insights, informing clinical guidance and counseling. These sources emphasize careful timing of exposure, close maternal and fetal monitoring, and interdisciplinary decision-making to optimize maternal treatment while minimizing potential neonatal risks [25]. Collectively, current evidence underscores the need for continued research, registry-based data collection, and cautious clinical application to ensure safe and effective use of emerging therapies in pregnant and lactating populations.

REGULATORY CHALLENGES: LABELING, CLINICAL TRIAL INCLUSION, POST-MARKETING SURVEILLANCE

Emerging therapies, including biologics, gene therapies, GLP-1 receptor agonists (GLP-1RAs), and novel small molecules, present unique regulatory challenges in the context of pregnancy and lactation. One of the primary concerns is the adequacy of drug labeling, which historically relied on simplified pregnancy risk categories and now follows the more detailed Pregnancy and Lactation Labeling Rule (PLLR) [25].. Despite this improvement, information on emerging therapies is often limited, resulting in incomplete guidance for healthcare providers regarding

maternal and fetal safety. Inclusion of pregnant and lactating women in clinical trials remains a significant challenge. Ethical concerns, liability risks, and physiological complexity often lead to their systematic exclusion, which restricts the availability of high-quality, prospective safety data [37].This limitation necessitates reliance on observational studies, registries, and post-marketing surveillance to monitor maternal and neonatal outcomes, but such methods may delay the identification of rare or long-term adverse effects [24].

Post-marketing surveillance and pregnancy registries are essential tools for capturing real-world safety data; however, regulatory coordination, reporting consistency, and international harmonization are often insufficient, particularly for novel therapies with limited historical use [6]. Addressing these challenges requires collaborative efforts among regulatory agencies, industry sponsors, and healthcare providers to enhance labeling clarity, encourage responsible inclusion in trials, and strengthen pharmacovigilance systems, ultimately improving the safe use of emerging therapies in pregnant and lactating populations [14].

Access Inequalities

Access to safe medications during pregnancy and lactation remains uneven globally. HICs generally benefit from rapid regulatory approval, established pharmacovigilance infrastructure, and subsidized healthcare programs. Conversely, LMICs encounter barriers including regulatory delays, high costs, limited safety monitoring, and cultural factors affecting drug use and reporting[43].Case studies from different regions illustrate how these inequities can result in delayed adoption of beneficial therapies and disproportionate maternal-fetal risk.

Comparative Analysis

Comparative assessments highlight significant differences in regulatory comprehensiveness and enforcement. Some countries exemplify best practices, including integrated labeling, robust risk management, and well-coordinated pharmacovigilance. Others demonstrate limited oversight or fragmented monitoring, indicating areas in need of improvement[44]. A Global Regulatory Scorecard can provide a visual representation of country-level performance in maternal-fetal drug safety, facilitating benchmarking and prioritization of interventions.

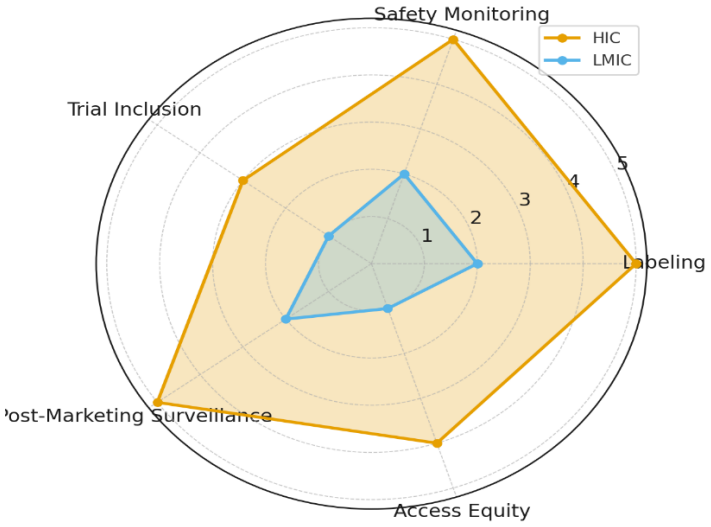

Figure 2: Comparative regulatory capacities of high-income countries (HICs) versus low- and middle-income countries (LMICs).

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Figure 2 provides a comparative visualization of regulatory capacities in high-income countries (HICs) versus low- and middle-income countries (LMICs), highlighting key disparities across labeling, safety monitoring, trial inclusion, post-marketing surveillance, and access equity."

OPPORTUNITIES AND RECOMMENDATIONS

To advance global maternal-fetal medication safety, inclusion of pregnant and lactating women in clinical trials for emerging therapies should be promoted under ethical and safety oversight [45], [46]. Strengthening pharmacovigilance infrastructure, integrating real-world data, and harmonizing regulations internationally can reduce inequities in access and safety assessment. Collaboration between regulatory agencies, clinicians, and patient advocacy groups is crucial for developing evidence-based, equitable policies that support the safe use of new therapies worldwide.

CONCLUSION

The current global landscape reflects significant advancements in maternal-fetal medication safety, particularly in high-resource settings where regulatory frameworks, risk management programs, and pharmacovigilance systems are well-established. Despite this progress, substantial gaps persist in low- and middle-income countries, where fragmented regulatory structures, limited safety monitoring, and barriers to access contribute to inequities in the use of safe therapies. Ensuring a balance between maternal and fetal safety, timely access to emerging treatments, and equitable healthcare delivery remains a critical priority. Strengthening evidence-based, harmonized regulatory policies, integrating real-world data, and expanding robust pharmacovigilance platforms are essential strategies to safeguard maternal and neonatal health. Furthermore, fostering international collaboration among regulatory authorities, clinicians, and patient advocacy groups is vital to promote the safe, effective, and equitable adoption of innovative therapies worldwide.

Conflicting Interests

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Data Availability

Study data are available publicly available in the mentioned databases.

Ethics approval and consent to participate

Not applicable

Credit authorship contribution statement

Riad Mohammed Abdelrahman& Taha Hussein Musa: Conceptualization, Methodology, **Ismail Adam Arbab, Mohsen Hussein Suliman, and Ala Gamaleldin Khalifa** :Formal analysis, Writing - original draft, **Eltieb Omer Ahmed**: Conceptualization, Writing - review & editing, **Sahar Ibrahim Gasmallah**: Formal analysis, Writing - original draft, **Wafaa Ramadan**

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Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work the authors used ChatGPT and Grammarly in order to enhance the readability and language of the manuscript. After using these tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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