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Barriers and future strategies on establishing fertility preservation centers in a developing country: A scoping review

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ABSTRACT

Objective: To identify barriers and future strategies for establishing fertility preservation in developing countries.**Methods:** A systematic literature search was conducted to identify studies/articles reporting in English on the barriers and strategies of fertility preservation in the developing countries. The literature search was conducted in PubMed, Cochrane Library, Scopus, and Google Scholar using search terms "challenges", "strategies", "fertility preservation", and "developing countries" to identify relevant sources from 2019 to 2024 applicable to current updates on fertility preservation.**Results:** A total of 34 studies were included in the analysis. Barriers were identified on healthcare providers and patients. Moreover, it could also be categorized as the backbone of an established fertility preservation center, which is an accessible assisted reproductive technology (ART) center. Without an established ART center, maintaining and utilizing the fertility preservation center would be challenging. Lack of awareness was another main barrier identified among healthcare providers. From the patient's perspective, the main barriers identified were the lack of financial support for fertility preservation programs and the awareness of fertility preservation programs. Policy, sociocultural, religious, knowledge, access to service, competency, and attitude were the other barriers identified. Few studies addressed strategies. Several strategies were identified, including improving access to ART facilities, enhancing financial support and policy for targeted patients undergoing fertility preservation, and increasing knowledge and awareness of healthcare providers and patients. However, further investigation is warranted.**Conclusions:** Several barriers have been identified for fertility preservation in developing countries. Therefore, corresponding strategies were proposed to specifically address them.**KEYWORDS:** Barriers; Future strategies; Fertility preservation; Developing countries; Reproductive health; Fertility services; Oncofertility

1. Introduction

Establishing a fertility preservation (FP) center in a developing country has its own mix of challenges and opportunities. As a

Key Points

Question: What are the barriers and future strategies for establishing fertility preservation in developing countries?**Findings:** In this scoping review of 34 studies, barriers to fertility preservation in developing countries included lack of accessible assisted reproductive technology (ART) centers, insufficient financial support, and low awareness among both healthcare providers and patients. Additional barriers involved policy, sociocultural factors, and limited access to services. Identified strategies included improving ART access, enhancing financial support, and increasing education for providers and patients.**Meaning:** Addressing financial, structural, and educational barriers through targeted, multi-level strategies is essential for establishing effective fertility preservation programs in developing countries.✉To whom correspondence may be addressed. E-mail: agungdewanto2009@gmail.com

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crucial aspect of reproductive healthcare, ensuring FP access to these services in developing countries is significant for addressing the diverse needs of individuals with fertility-threatening conditions. In this scoping review, we aimed to explore the existing literature on this topic and identify future strategies for successful implementation. This review sought to contribute valuable insights into the field of reproductive medicine and healthcare policy in developing countries by investigating the challenges and potential solutions[1]. These barriers pose significant obstacles to the establishment and maintenance of FP centers in these regions[2].

FP in developed countries including Europe, the United States (US), and Japan, has achieved significant advances owing to increased cancer survival rates and greater recognition of patients' long-term quality of life[3]. Developed countries have implemented comprehensive and structured systems for FP, benefitting from the existing healthcare infrastructure and expertise from assisted reproductive technologies (ARTs), notably *in vitro* fertilization (IVF) centers. Integrating these comprehensive facilities has played a crucial role in expanding FP services.

In Europe, particularly in Germany, Austria, and Switzerland, the FertiPROTEKT network is a decentralized approach, facilitating both access and standardization[3]. The network coordinates more than 125 centers, several of which are IVF clinics, and ensures patient counseling, tissue processing, and data collection. IVF centers are significant factors for infrastructure, specialized staff, and cryopreservation capabilities necessary for FP.

In other European countries, such as Denmark, a centralized model is employed through its national FP program. The “woman stays, the tissue moves” concept exemplifies how centralized cryopreservation laboratories function in synchrony with local surgical and fertility clinics. IVF units within public hospitals perform ART procedures, coordinate consultations, and follow up post-transplantation. The success of the Danish model is attributed to its clear organizational structure, government funding, and centralized expertise[3,4].

In the US, the Oncofertility Consortium exists as a decentralized academic research-based network[3,5]. Several participating institutions are large academic centers with established IVF laboratories. These centers enable access to cryopreservation services and have the technological capacity to support research, including *in vitro* follicle maturation and ovarian tissue transplantation. Despite the availability of advanced medical facilities, the uneven access to services and lack of standardized national insurance coverage represent a major challenge in the US[3,5].

In developed Asian countries, including Japan, cases of FP have been steadily increasing. The Japan Oncofertility Registry, launched in 2018, has enabled a robust data collection system tracking demographic trends, cancer types, preservation methods, and outcomes. IVF centers in Japan are essential to implementing oocyte

and embryo freezing, ovarian tissue cryopreservation, and ART post-treatment[6].

In developed countries, the advancement of FP is mainly caused by the following enabling factors: robust healthcare systems, high availability of IVF centers, government or insurance support (at varying levels), and strong interdisciplinary networks. Additionally, these centers promote standardization, research, and education. However, despite FP program advancement, several setbacks and challenges may still be encountered even in developed countries, including limited interdisciplinary coordination with oncologists, a lack of universal health insurance coverage for FP treatments, regional disparities in service availability, and delays in referral and initiation of preservation[3,5,6].

Establishing FP programs in developing countries faces challenges owing to limited resources[7]. Significant costs associated with equipment, drugs, and procedures present obstacles for healthcare facilities in offering these services, leading to restricted access for individuals[8]. The lack of access to IVF centers in developing countries may further compromise the establishment of FP centers[9]. Inadequate awareness and education about FP among healthcare providers and the general public hinder the integration of these services into the existing healthcare system[8]. Traditional beliefs about fertility may discourage individuals from seeking these services, causing underutilization of available resources[8,10]. Moreover, inadequate infrastructure, including a lack of qualified medical personnel and facilities, further complicates FP establishment in these regions.

Addressing these difficulties will necessitate a comprehensive strategy, encompassing increasing access to IVF facilities, education, promotion, and policy adjustments. Raising awareness about the significance of FP through public health initiatives and focused educational efforts can debunk myths and misunderstandings, ultimately overcoming cultural impediments to obtaining these service[11,12].

This review aimed to comprehensively investigate the obstacles and strategies associated with establishing FP in developing countries. We mainly aimed to comprehensively evaluate the current research on this subject and identify potential obstacles and opportunities for effectively implementing FP programs in these areas.

This review aimed to focus on exploring the diverse challenges that foster significant barriers for setting up and maintaining FP centers in developing countries. Moreover, we sought to explore potential solutions to overcome these hurdles. Through a comprehensive identification of existing literature along with an in-depth analysis, we aimed to provide a thorough understanding of the complexities involved in establishing sustainable and effective FP programs in developing countries.

2. Methods

2.1. Protocol

This study employed a scoping review method as it can provide the range and comprehensive significance in the field of FP. This scoping review was conducted using the Joanna Briggs Institute methodology[13], based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews to implement robust quality measures in reporting[14]. We structured this scoping review using the following stages: (1) Clearly defining the review questions; (2) Systematically searching for relevant literature; (3) Selecting studies on the basis of predefined criteria; (4) Extracting and organizing data from selected studies; and (5) Interpreting the results and emphasizing significant findings.

2.2. Eligibility criteria

This scoping review included clinical trials, literature reviews, case reports or case series, and other descriptive studies addressing barriers and strategies related to FP in developing countries.

Commentary-type publications (*e.g.*, letters to the editor), articles without available full text, and non-English publications were excluded.

2.3. Information source

A three-step search strategy was performed based on Joanna Briggs Institute's recommendations. A systematic literature search was conducted to identify studies/articles reporting on the barriers and strategies of FP in the developing countries. The literature search was conducted to identify relevant sources from 2019 to 2024 that are applicable to current updates on FP. We utilized four databases (PubMed, Cochrane Library, Scopus, and Google Scholar). We focused on papers published in English. Our search terms were designed to narrow down the results to encompass challenges, strategies, FP, and developing countries. We utilized synonyms and Medical Subject Heading (MeSH) namely MeSH terms for each keyword, in addition to incorporating all the developing countries listed in the United Nations' 2023 report.

2.4. Searching evidence

We used the following as our final searching strategies: ("Fertility Preservation"[Mesh] OR "Cryopreservation"[Mesh] OR "Oncofertility"[Title/Abstract] OR "fertility preservation"[Title/Abstract] OR "sperm cryopreservation"[Title/Abstract] OR "oocyte cryopreservation"[Title/Abstract] OR "embryo cryopreservation"[Title/Abstract] OR "ovarian tissue cryopreservation"[Title/Abstract] OR "GnRH agonist"[Title/Abstract]) AND ("Health Services Accessibility"[Mesh] OR "Healthcare Disparities"[Mesh] OR barrier*[Title/Abstract]

OR challenge*[Title/Abstract] OR obstacle*[Title/Abstract] OR strateg*[Title/Abstract] OR awareness[Title/Abstract] OR knowledge[Title/Abstract] OR attitude*[Title/Abstract] OR access*[Title/Abstract] OR policy[Title/Abstract] OR sociocultural[Title/Abstract]) AND ("Developing Countries"[Mesh] OR developing countr*[Title/Abstract] OR low- and middle-income countr*[Title/Abstract] OR LMIC*[Title/Abstract] OR Asia[Title/Abstract] OR Africa[Title/Abstract] OR "South America"[Title/Abstract] OR "Middle East"[Title/Abstract]).

2.5. Selection of source of evidence

Our research process encompassed a systematic approach for identifying and selecting relevant studies. We began by identifying key articles and subsequently investigated their reference lists to identify additional sources. Using Mendeley, a reference management software, we organized our collection and removed duplicate entries. Next, two authors (SA and HNU) independently reviewed the titles and abstracts of the remaining articles, narrowing our focus to those specifically addressing FP challenges and future strategies in developing countries. Subsequently, we conducted full-text reviews of these selected papers, paying close attention to discussions about barriers and strategies within the context of developing countries. The screening process is illustrated in Figure 1.

2.6. Data charting process

To collect key information from the selected articles, we performed a structured data extraction system using Microsoft Excel and Google Docs. This system facilitated the compilation and organization of data points, including author names, publication year, research location (country and continent), country's economic status, study design elements (purpose, design, methodology, and participant demographics), core concepts addressed, outcomes measured, and a summary of key findings. This summary of key findings included a concise overview of study results, author conclusions, and remarkable observations from each article.

2.7. Data item

The extracted data were organized in a table using Microsoft Excel 2010 and categorized according to author, publication year, country and continent, study objective, data collection methods, key findings, and research focus or domain.

2.8. Summarizing evidence

To ensure a detailed and collaborative analysis, two researchers independently reviewed and summarized each study that met our inclusion criteria. Subsequently, we used systematic content analysis to systematically code and categorize the data, focusing specifically on themes associated with barriers and strategies for

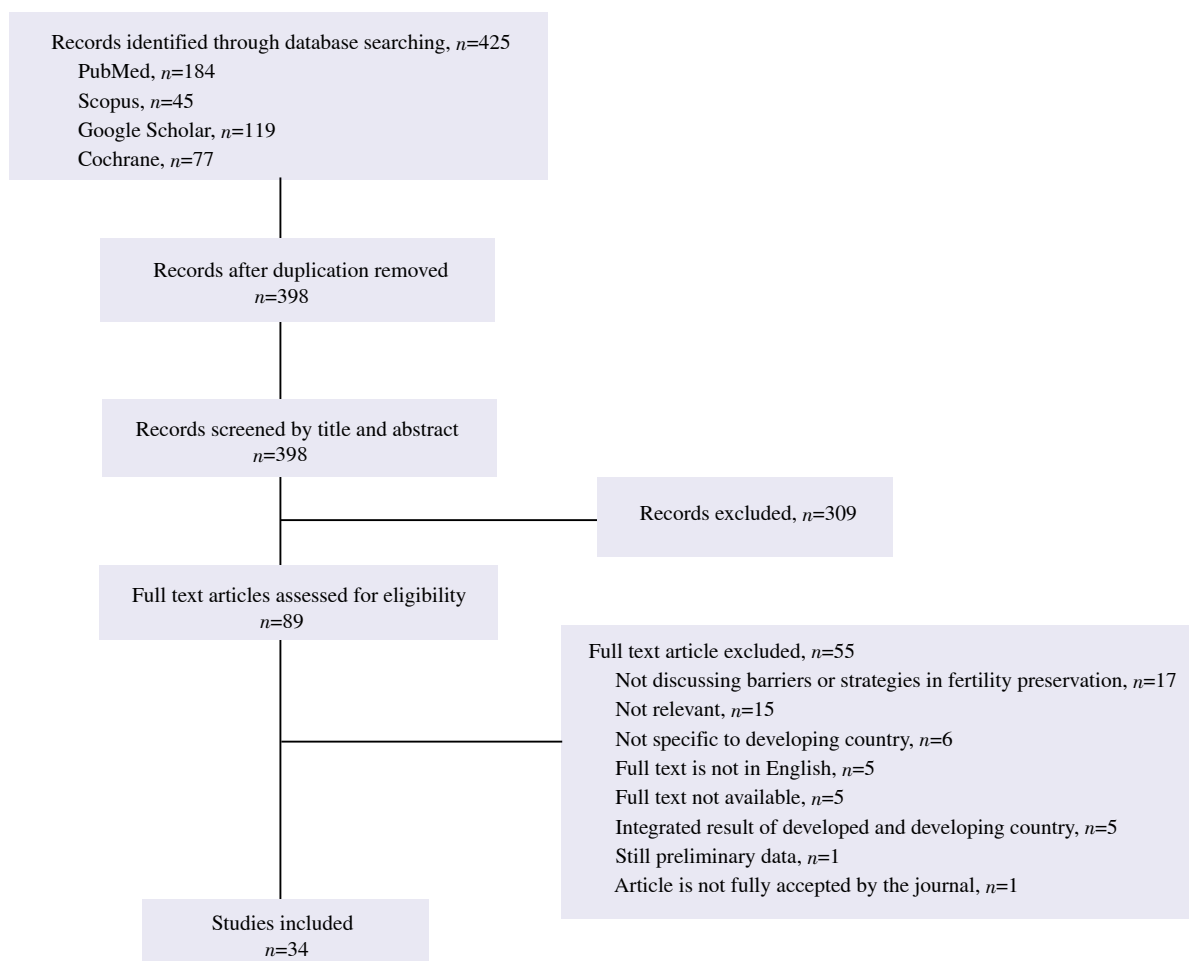


Figure 1. Flowchart of the included studies screening process.

FP in developing countries. To identify common patterns, similar themes emerging from different studies were grouped together. One researcher then drafted a preliminary analysis of the findings, which was subsequently reviewed and refined through discussion and feedback from all co-authors.

3. Results

3.1. Selection of articles and characteristics of evidence

We identified 425 records, 398 of which remained following duplicate removal. When screening titles and abstracts, 89 full-text documents were deemed eligible for full-text review. From these articles, 34 were included for this review. Data extracted from individual studies are described in Table 1.

Data were extracted from 34 studies worldwide. 26 studies were conducted in 10 countries in Asia (10 in India, 9 in China, 4 in Indonesia, 4 in the Philippines, 3 in Iran, 3 in Turkey, 2 in Saudi Arabia, 2 in Thailand, 1 in Vietnam, and 1 in Lebanon). Meanwhile, six studies were performed in South America, spreading from seven countries (Columbia, Argentina, Chile, Panama, Brazil, Uruguay,

and Peru). In Africa, seven studies were conducted in six countries (Nigeria, South Africa, Egypt, Tunisia, Kenya, and Morocco). Mexico and Guatemala were the only two countries from North America that conducted seven studies in accumulation. Meanwhile, one study from Romania was the only study conducted in Europe. The distribution of the studies based on countries is depicted in Figure 2.

This study predominantly favored quantitative methodologies (25 articles, 73.53%), highlighting an emphasis on objective measurement and statistical analysis. Although qualitative methods represented a smaller portion (6 articles, 17.65%), an increasing trend toward mixed-method approaches (3 articles, 8.82%) acknowledged the value of integrating both quantitative and qualitative insights. Over half of the studies (18 articles, 52.94%) utilized a survey design, reflecting a common approach for large-scale data collection. Furthermore, cross-sectional studies, providing a snapshot of a phenomenon at a specific time, comprised a substantial portion (12 articles, 35.29%). Other methodologies, including prospective, cohort, literature review, observational, and survey study with opinion designs, were far less prevalent, each accounting for only 2.94% (1 article) of the total number of included studies.

Study characteristics show that the majority of included studies

were quantitative in design, accounting for 73.53% ($n=25$), while qualitative studies comprised 17.65% ($n=6$) and mixed-methods studies 8.82% ($n=3$). In terms of study design, survey-based studies were most common (52.94%, $n=18$), followed by cross-sectional studies (35.29%, $n=12$). Other designs, including prospective cohort, literature review, observational, and survey with opinion components, were each represented by a single study (2.94%).

3.2. Barriers of FP in the developing countries

Most studies primarily discussed barriers to FP (67.65%, $n=23$), whereas 26.47% ($n=9$) addressed both barriers and strategies. Several barriers of FP faced in the developing countries can be extracted from the studies which are described in Table 1.

3.2.1. Barriers of FP faced by healthcare providers in developing countries

Healthcare professionals were mostly observed in researches, with 55.88% (19 articles) dedicated to understanding their perspectives, practices, and challenges. Table 1 highlights a wide range of barriers to FP in developing countries from the perspective of healthcare providers and also from perspective of the patients. These barriers can be broadly categorised as either non-human or human resource-related.

From the perspective of healthcare providers, among the non-human resource barriers, limited access to ART services is a significant challenge, with many centres lacking the necessary procedures for FP, such as freezing ovarian tissue and social egg freezing. Policy-related constraints further complicate implementation, including the absence of, or restrictions on, legal frameworks; the lack of national guidelines; the absence of FP societies or registries; and the difficulties in overcoming regulatory limitations. Financial barriers are also significant, with high procedure costs, inadequate institutional funding and limited insurance coverage restricting service provision and patient access.

Human resource barriers encompass competency-related issues, sociocultural and religious factors, awareness, and professional attitudes. Limited expertise, insufficient training, a lack of fertility specialists and underutilisation of available technologies hinder the optimal delivery of FP services. Sociocultural and religious beliefs may lead to reluctance among providers or broader societal rejection of FP services. Additionally, low awareness and knowledge among healthcare providers contribute to inadequate counselling, poor referral practices, and weak multidisciplinary collaboration. Attitudinal barriers, such as time constraints, concerns about delaying cancer treatment, discomfort when discussing FP options and assumptions based on patient prognosis, further limit the integration of FP into routine clinical care.

3.2.2. Barriers of FP faced by patients in developing countries

Emerging areas of interest, although less frequently addressed, included community-focused research and oncofertility-related topics (1 article each, 2.94%). Several literature 17.65% ($n=6$) focused on patients and 20.59% ($n=7$) addressed both groups, patients and healthcare providers.

Several studies mentioned the various barriers to FP faced by patients in developing countries, which can be categorised as either non-human or human resource factors. In terms of non-human resource barriers, limited access to services is a major challenge, as FP procedures are often only available in private centres that have well-established ART facilities. Patients also face limited options for FP procedures, a shortage of qualified providers and difficulties in locating suitable facilities. Financial constraints further exacerbate access issues, with high procedure costs and limited or absent insurance coverage representing significant obstacles.

Human resource-related barriers are largely influenced by sociocultural, religious and knowledge-related factors. Cultural norms and regulatory gaps may restrict eligibility for FP, often limiting access to married heterosexual individuals and creating dependency on marital status or parental approval. Religious beliefs may also discourage certain procedures, and concerns about bodily integrity can affect acceptance. Additionally, low awareness and insufficient knowledge about FP among patients and the wider community can lead to a poor understanding of the issue and limited demand. FP is often not prioritised, particularly when immediate health concerns take precedence or when education levels are low. These results are described in Table 1.

3.3. Strategies of establishing FP in developing countries

Strategies on establishing FP are mentioned in several literatures. Only a small proportion examined the community or oncofertility registries (each 2.94%, $n=1$). Only a limited number focused solely on strategies (5.88%, $n=2$). Table 2 presents key strategies mentioned for establishing FP programmes in developing countries, categorised as either non-human or human resource approaches. From a non-human resource perspective, improving access to services is central, involving expanding the range of FP techniques, promoting fertility-sparing interventions, integrating fertility counselling into cancer care and setting up dedicated FP centres and collaborative programmes such as Reproduction and Cancer in the Oncofertility Professional Engagement Network (Repro-Can-OPEN). Financial strategies aim to reduce patient costs through subsidies, discounts and improved affordability, as well as integrating FP funding into national healthcare systems to ensure equitable access (Table 2).

Policy-related strategies emphasise strengthening system-level support by developing national registries, expanding governmental coverage and incorporating FP discussions into routine clinical practice. Positioning FP as part of public health services is also highlighted as a key step towards wider implementation. From a

Table 1. Barriers of fertility preservation in the developing countries.

Category	Barriers
Barriers encountered in developing countries faced by healthcare providers	
Non-human resources barriers	
Access to service	Access to assisted reproductive technology (ART) including fertility preservation (FP), such as ovarian tissue freezing and social egg freezing are not available[8,15] Social egg freezing is not available[8,15] Ovarian tissue freezing is not available[8,15,17] Advanced techniques of ART are not available at most centres[18]
Policy	Partial law restriction to certain FP procedure[8,18,21] FP procedures are not yet regulated by the law[8,15] Total restriction of the law to FP procedure[8,15] No local guideline on FP treatments[12,22] No FP society[12] No national registry of FP[8,15,23] Overcome legal barriers are impossible[8,15]
Financial	Limited or no insurance coverage for FP procedure[8,12,15,21] Inadequate institutional and research funding[8,15,21] High cost of the FP procedure[16–19]
Human resources barriers	
Competency of healthcare providers	Delay in cancer diagnosis and treatment[8,15] Lack of fertility specialist[8,15,19] Underutilized technology in providing ART and FP treatments[16] Medical technology in ART of FP is behind[16] Limited experience or competencies of healthcare providers in ART or FP[20] No referral regulation regarding FP[12]
Sociocultural and religious	Few of FP procedures are not accepted socially[8,15,21] Majority of FP procedure are not accepted socially[8,15] Health care professionals are reluctant to provide FP treatment[16] FP is regarded as unnecessary because the adoption system is popular[16] FP only offered for patients in certain age[24–28] Overcome social barriers are impossible[8,15] Religious barrier from certain health care professional's religion about FP permissibility[18,22,26]
Awareness or knowledge	Lack of awareness among health care professionals[8,15–17,22,24,28–31] Lack of consult or referrals to fertility specialist[8,15,20–22,24,25,29,31,32] Lack of knowledge about FP among health care professionals[19,20,22,26,28,29,32–38] Multidisciplinary team is not well established[8,15,16] Healthcare providers did not give adequate information about FP treatment to the patient[12,20,27]
Attitude of healthcare providers	Insufficient time in medical visits to address fertility issue[19] Poor patient's prognosis tends to prevent healthcare providers from FP discussion[19] Fear of delaying cancer treatments from health care professional[18,19,29] Healthcare providers did not comfortable to discuss certain FP options[37] Potentially heritable cancer tends to prevent healthcare providers from FP discussion[28]
Barriers encountered in developing countries faced by patients	
Non-human resources barriers	
Access to service	FP procedure mostly only available in private centers with established ART facilities[8,15] Not many options for FP procedures available along with lack of ART facilities[8,15] A limited number of providers and difficulty in finding proper facilities for FP procedure[21,39] Problems with tissue donation related to FP[21]
Financial	Limited or no insurance coverage for FP procedure[8,12,15–46] High cost of the FP procedure[8,15–17,20,21,37,45]
Human resources barriers	
Sociocultural and religious	No regulation about who can receive FP procedure[8,15] Few of FP procedures are not accepted socially[8] Only married heterosexual couples are allowed to undergo FP[8] The patient's parents are reluctant about FP treatments[16] The patient's marital status determines whether or not the FP procedure can be carried out[15,20] Patients fear that certain FP procedures may disrupt the integrity of the hymen[21,39] FP only offered for patients who wants to get pregnant in the future[31,45] Barrier to the transvaginal egg collection procedure based on patient's religious beliefs[39] Religious barrier from certain patient's religion about FP permissibility[21]
Awareness or knowledge	Insufficient awareness among patients[8,15,37,41–43] Limited recognition of FP in society[16] Patients feel they do not have enough information about FP[16,36,39,41] Infertility was not the biggest concern for the patients (or patient's parent)[39,45] Low education level of the patients[39,42,43] Lack of knowledge among patients[43,44]

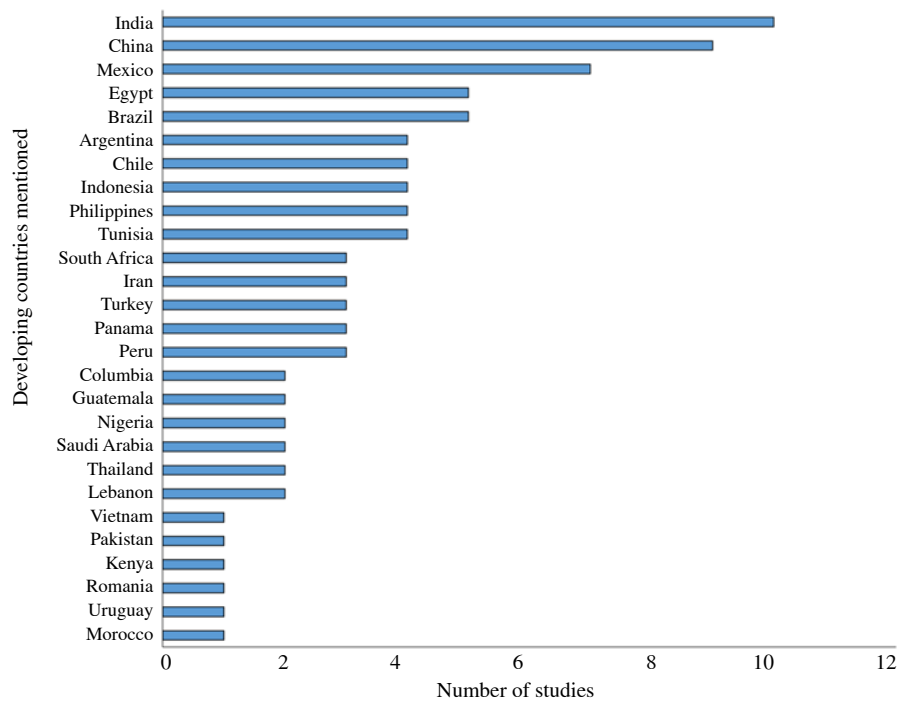


Figure 2. Number of studies mentioning fertility preservation (FP) in developing countries. Thirty-four studies were reviewed globally.

Table 2. Strategies of establishing fertility preservation in developing countries.

Category	Strategies
Non-human resources strategies	
Access to service	Provide a lot of variety of fertility preservation treatments[8] Encourage healthcare providers to do fertility sparing surgery and radiation shielding[16] Providing a fertility counselor in cancer treatment centers or other centers that expose patients to infertility risks[28,31] Established a center dedicated for fertility preservation[22] REPRO-CAN OPEN (Reproduction and Cancer in the Oncofertility Professional Engagement Network) Programs[46]
Financial	Funds and discounts for patients going through fertility preservation procedure[40] Improve financial accessibility to fertility preservation services[29] Funding fertility preservation through the healthcare system to ensure equitable access for every patient[15,17]
Policy	OPEN (Oncofertility Professional Engagement Network)[8] Establishment of national registry of fertility preservation or oncofertility[8] Sustained and extended governmental coverage of fertility preservation options[40] Healthcare providers are asked to routinely discuss fertility preservation options in the part of an examination[26] Fertility preservation should be offered as a public health service[22,31]
Human resources strategies	
Awareness or knowledge	Enhance patients' knowledge about fertility preservation through education or educational materials[22,29,31]

human resource perspective, it is essential to enhance awareness and knowledge among patients, primarily through education and the dissemination of accessible informational materials, to improve understanding of, and uptake of, FP services (Table 2).

4. Discussion

This scoping review depicted the most comprehensive and thorough

investigation on barriers and strategies during FP establishment in developing countries, which are countries whose development remains below average (in terms of place of income, standard of living, economic, and industrial development). In this scoping review, of the 34 included studies, 27 developing countries were mentioned.

Most of the countries referenced were from the middle-income category. This finding indicates that not much research has been conducted for low-income countries and that FP, as well as ART, has

not been a priority in those countries.

Most of the included studies discussed barriers in FP treatments. Twenty-three studies (67.65%) exclusively discussed barriers[12,18,21–23,25–27,30,32–39,41–45], and nine studies tackled both barriers and strategies[8,15–17,22,26,28,29,31]. This result implies that in the developing countries, most researchers remain at the level of identifying barriers rather than seeking “the solution” or strategies.

In this review, we agreed that the following are the four significant domains of FP challenges on utilization: patient, socioeconomic, oncology care provider-related, and institutional factor[47,48]. Most studies investigated on healthcare providers (55.88%)[17–20,22,24–35,37,38], whereas only 17.65% of the included studies examined patients[39,40,42–45]. We identified every example of barriers from all of the four domains. Most of the barriers that were frequently observed in the majority of developing countries were non-human resource barriers (*e.g.*, financial, policy, and established system) and human resource barriers (*e.g.*, awareness and attitude of healthcare providers). These findings were also consistent with this review.

We observed that among healthcare providers in developing countries, the lack of access to ART services represent the most crucial barrier[9]. As we have known, established ART services were the crucial basis of the most options for FP procedures. Meanwhile, Dewi *et al* stated that there remain several barriers of undergoing ART in developing countries, including the high cost of ART services, limited access, lack of ART centers in certain areas, insufficient qualified staff, inadequate government support, low priority in policy, social cultural factors (*e.g.*, religion and false beliefs), and several other barriers that prevent ART programs to be implemented in developing countries[9]. An established and well-functioning IVF service is the foundation of effective FP services. When several barriers to implementing the IVF program exist, multiple barriers to performing FP also exist. Ojo *et al* also mentioned that ART services are nonexistent in 16 of 26 low-income countries reported. Without these services, conducting research or even participating in providing FP procedures is difficult[48].

Interestingly, not only the lack of access to services but also human resource barriers, including “lack of awareness among healthcare professionals” (21/27 [77.78%] developing countries mentioned)[15–17,22,24,28–31], followed by “lack of consult or referrals to fertility specialists” (20/27 [74.07%])[8,15,20–22,24,25,29,31,32], “no national registry of FP” (19/27 [70.37%])[8,15,23], and “limited or no insurance coverage for FP procedures” (17/27 [62.96%])[8,12,15,21], were commonly mentioned as barriers. It also indicated that healthcare providers do not adequately recognize FP-related issues.

From the patient’s perspective, the top five barriers identified are mostly financial or awareness barriers, including “limited or no insurance coverage for FP procedures” (20/27 [74.07%])[8,12,15–46], “high cost of FP procedures” (18/27 [66.67%])[8,15–17,20,21,37,45], “insufficient awareness among patients” (17/27 [62.96%])[8,15,37,39,41–43],

and “FP procedure mostly only available in private centers” (12/27 [44.44%])[8,15]. FP is costly, further exacerbating these challenges. Additionally, most developing countries mentioned in this study do not have insurance coverage for this procedure. Moreover, in the high-income category, two from the top three barriers are funding barriers - “limited or no insurance coverage for FP procedures” (3/5 countries)[8,15,21], and “inadequate institutional and research funding” (3/5 countries)[8,15] (with the first being “no national registry of FP”). This finding suggests that in high-income countries, the challenge is shifted to funding barriers, with awareness or lack of access for the facilities not being the priority. In the three regions (Asia, Africa, and Latin America), “limited or no insurance coverage for FP procedures” and “high cost of FP procedures” remain the top three barriers mentioned in each region, along with “insufficient awareness among patients” or “patients feel they have insufficient information about FP.”

Reflecting on developed countries, FP has been strongly supported from various perspectives[25]. In Japan, FP facilities have been established with thorough management. Maezawa *et al* stated that Japan implements a comprehensive and organized system in case of FP storage and transport, including prevention system in case of facility closure, with 20.5% of facilities having an approved transfer site. In the management of liquid nitrogen containers, 83.1%, 65.1%, and 16.9% of facilities regularly replenished the liquid nitrogen, regularly checked the amount, and had alarm monitoring systems, respectively. Regarding disaster countermeasures, 70.9% of facilities had taken measures to protect specimens[49]. Moreover, Denmark and Germany already implemented a cryopreservation transportation system through FertiPROTEKT, leading to >20 neonates being born[50].

In this review, to overcome these barriers, we noted two examples of proposed comprehensive strategies, including Oncofertility Professional Engagement Network (OPEN) and Reproduction and Cancer in the Oncofertility Professional Engagement Network (Repro-Can-OPEN). The OPEN strategy connected professionals and trainees who share a common passion for oncofertility and reproductive health, both in the US and internationally. With 25 sites involved, OPEN aims to harness the collective expertise of its members by developing a system for sharing information. This framework enables each center to adapt the knowledge to their specific needs, including establishing the ART center, and ultimately advancing the field into FP. By bridging the gap between domestic and international programs, OPEN fosters a strong global network where members can exchange resources, methodologies, and experiences, while also enhancing cultural competence in oncofertility[8].

Meanwhile, the Repro-Can-OPEN study builds on the initiatives of the OPEN programs to address the challenges of limited resources in developing countries, particularly in the complex field of oncofertility. This strategy also aimed to bridge the gap between

international oncofertility programs and the standards in developing countries. It focused on helping these countries establish specific oncofertility programs for prevalent cancers, including childhood, breast, and blood cancers, tailored to their current challenges and opportunities[46].

5. Study's limitations

This scoping review has several limitations. Firstly, the available evidence is unevenly distributed across developing countries, with only a limited number of countries contributing publications on FP. This may reduce the generalisability of the findings, as the identified barriers may not fully represent all low- and middle-income settings. Secondly, most of the included studies focused primarily on identifying barriers, with relatively few addressing practical solutions. This results in an imbalance between problem identification and solution-oriented evidence.

Furthermore, as this is a scoping review, it did not assess the quality or risk of bias of the included studies, which may affect the robustness of the conclusions. The heterogeneity in study designs, populations and contexts also limits direct comparison and synthesis. Finally, potential publication bias and the exclusion of non-English articles may have resulted in the omission of relevant data, particularly from underrepresented regions.

6. Conclusions and future prospect

Alongside the varying barriers experienced by each country, the strategies employed by each nation remain context-specific and distinct. However, establishing an ART programme supported by multidisciplinary stakeholder collaboration is fundamental to strengthening the development of FP services. Sociocultural barriers also necessitate a tailored approach that is sensitive to local circumstances in different settings. Future perspectives should focus on developing context-adapted implementation frameworks, integrating FP into national cancer and reproductive health policies, and expanding cost-effective, simplified FP technologies suitable for low-resource settings. Improving access and standardising care will require strengthening provider education, establishing national registries, and fostering international collaborations. Therefore, comprehensive, implementation-oriented research is essential to bridge existing gaps and support the sustainable development of FP programmes in developing countries.

Conflict of interest statement

The authors declare no conflicts of interest.

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Authors' contributions

Agung Dewanto contributed to the development of the study's conceptual framework, definitions, and overall design. Sarrah Ayuandari and Hana Nurhidayati Utami conducted the investigation, performed the literature search, and carried out data analysis. The manuscript was written, revised, and reviewed by Sarrah Ayuandari and Agung Dewanto.

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