A Survey of Experiences in Latin America and the Caribbeanesponsible Artificial Intelligence (AI)

Technical Document 4

Authors: Martin Saban, Denise Zavala,Analía López, Santiago Esteban,Adolfo Rubinstein and Cintia Cejas
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According to data from the United Nations Population Fund (UNFPA), most interventions in sexual and reproductive health are cost-effective. Reducing unintended pregnancies and unsafe abortions, preventing HIV and STI infections, providing affordable contraceptive methods, and offering sexual health counseling are sustainable, low-cost interventions. If investments in sexual and reproductive health services in developing countries are increased and sustained, huge benefits can be achieved. For instance, family planning enables women to reach higher levels of education 9 and a better balance between family and work. Prenatal care and obstetric services protect the health of the mother and child. Comprehensive Sexual Education is a fundamental resource for empowering young people to make informed and responsible decisions and avoiding unintended pregnancies and STIs. The convergence between the health sector and technology allows for leveraging innovative and cost-effective platforms to strengthen local and global capacities, maximizing many of the above-mentioned interventions. In recent years, the exponential growth of digital data, the implementation of health information systems, increased computing capacity, and advances in programming and coding artificial intelligence (AI) algorithms have driven digital transformation initiatives. AI offers various applications, including machine learning, natural language processing, understanding and generation, speech analysis, conversational virtual agents (chatbots), robotics, and many other tools. These tools can overcome certain limitations by providing efficient and accessible healthcare and contributing to achieving Sustainable Development Goals (SDGs) in health. However, as mentioned in CLIAS's Technical Document 1, the development of AI in the health sector is still at an exploratory stage in the region, meaning that the criteria for a truly integrated ecosystem have not yet been met. This creates challenges in integrating and implementing strategies to cover priority health needs and strengthen health access. This document aims to survey and analyze the applications of artificial intelligence tools in the fields of sexual health, reproductive health, and maternal health in Latin America and the Caribbean through an exploratory literature review. The relationship between artificial intelligence (AI) in the healthcare domain and ethics is a topic of growing interest and debate. AI is defined as the field of study and development of systems and technologies capable of simulating human intelligence to carry out complex tasks autonomously.

CLIAS

CENTRO DE INTELIGENCIA ARTIFICIAL Y SALUD PARA AMÉRICA LATINA Y EL CARIBE

Artificial Intelligence and Sexual, Reproductive and Maternal Health (SRMH): A Survey of Experiences in Latin America and the Caribbean

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Index

Work team

Martin Saban: Pediatrician (University of Buenos Aires). Member of the Information and Communication Technologies subcommittee of the Argentine Society of Pediatrics. Candidate for a Master's Degree in Clinical and Health Effectiveness. CIIPS-IECS Fellow.

Denise Zavala: Degree in Psychology (UBA). Diploma in Management of Health Policies in the Territory (UNGS). Candidate for a Master's Degree in Clinical Effectiveness (UBA). CIIPS-IECS Fellow.

Analía López: Family Physician (CEMIC University Institute). Master's Degree in Clinical and Health Effectiveness (UBA). Diploma in Gender, Society and Politics (FLACSO) and in Medical Education (Universidad Nacional de Tucumán (Instituto Universitario CEMIC). Specialist in strategic business management and business innovation (George Washington University School of Business). Chief of Staff of the Ministry of Health of the Nation (2017-2019). Senior Consultant in Health Systems and Policies (CIIPS-IECS).

Santiago Esteban: Family Physician (Universidad Austral). Master in Public Health with a focus on data at the Harvard T.H. Chan School of Public Health. Manager of Health Information Management and Statistics in the Government of Buenos Aires City. Staff Researcher in AI at the intersection of epidemiology, public health, machine learning, causal inference, data science, and information systems at CIIPS-IECS.

Adolfo Rubinstein: Family Physician (UBA). Master's degree in Clinical Epidemiology from Harvard T.H. Chan School of Public Health, Diploma in Health Economics from the University of York. PhD in Public Health (UBA). Regular Professor of Public Health (UBA). Certificate in Public Policy Implementation from the Harvard Kennedy School. Minister of Health of the Nation of Argentina (2017-2019). Director of the Center for Implementation and Innovation in Health Policies (CIIPS-IECS).

Cintia Cejas: Bachelor's Degree in Political Science (UCA) and Master's Degree in Social and Health Sciences (FLACSO-CEDES). Specialist in health project management. Coordinator of the Center for Implementation and Innovation in Health Policies (CIIPS-IECS) and the Center for Artificial Intelligence in Health for Latin America and the Caribbean (CLIAS).

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Presentation

This document, prepared by the Center for Implementation and Innovation in Health Policies (CIIPS) of the Institute for Clinical and Health Effectiveness (IECS), is part of a Series of Technical Documents on Artificial Intelligence and Health (https://clias.iecs.org.ar/publicaciones/).

These documents aim to contribute to the knowledge in the region by addressing different relevant axes and perspectives in the analysis of this topic.

Intended for healthcare teams, decision-makers at all levels, and the general population, with a special interest in the digital transformation of the healthcare sector, these documents complement the activities carried out by the Center for Artificial Intelligence in Health for Latin America and the Caribbean (CLIAS), which is developed at CIIPS with the support of the International Development Research Centre (IDRC). For more information about CLIAS, visit http://clias.iecs.org.ar

This document is a scoping review aimed at identifying the applications of artificial intelligence tools in sexual, reproductive, and maternal health in Latin America and the Caribbean. The drafting and reporting of the review follow the methodological framework proposed by Arksey and O'Malley for scoping studies.[1] This methodology is well-suited to the breadth of our research question, enabling us to identify and present the available evidence rigorously and reproducibly. The research questions guiding the review are as follows: **What are the specific areas of sexual and reproductive health that have been addressed with artificial intelligence in Latin America and the Caribbean? Are they intended for the general population or specific groups? What type of artificial intelligence do they utilize? At what stage of development are these tools currently?**

Key Messages of the Document

- The development of artificial intelligence (AI) in sexual, reproductive, and maternal health (SRMH) is in an exploratory stage, which raises questions about the application of these tools in the region.
- As a result of the search, out of the 1,518 articles identified, 143 were included in this study. The distribution of articles by country is as follows: Mexico (29), Colombia (28), Peru (24), Brazil (14), Argentina (14), Chile (9), Ecuador (4), Guatemala (4), Cuba (3), Bolivia (2). From Nicaragua, Panama, Venezuela, and the Dominican Republic, one article per country was identified. Finally, three articles were found that applied artificial intelligence in two SRMH services simultaneously.
- The review shows a clear **orientation towards artificial intelligence projects in the areas of prenatal, childbirth and postnatal care and prevention, and detection and treatment of cancers of the reproductive organs**.
- In line with the predominance of AI tools in these areas of SRHR, the **target population of most studies comprises pregnant individuals and those with cancer.**
- The articles reviewed mainly employ **machine learning and deep learning techniques.**
- Regarding the developmental stages of AI tools in SRMH, **48% are exploratory projects representing the genesis of new ideas and concepts**, marking the beginning of innovative research aimed at addressing specific challenges in SRMH through the application of AI. **17% represent projects where it is described that AI tools are operational, although there is no report on results** regarding their performance or effectiveness. **The remaining 35% are implemented projects, which offer a more comprehensive evaluation** and provide evidence of the effectiveness of AI tools in the field of SRMH.
- The findings underscore the need to focus on developing and diversifying AI applications, as well as the inclusion of diverse populations, to ensure equitable and effective access to reproductive health and sexual health services.
- These results also raise **new questions about whether, despite their technical efficacy, these tools impact the decision-making and actions of health professionals in their daily practice, as well as how the technical performance of the tools can produce significant changes in health outcomes for users.**

Glossary of AI Terms

Machine Learning: It is a branch of artificial intelligence that allows machines to learn from data and improve their performance in specific tasks without being explicitly programmed for them.

SVM - Support Vector Machines: These are supervised learning models used for classification and regression. They recognize boundaries that help categorize data into different groups.

Random Forests: This is a supervised learning model that creates multiple decision trees during training to classify and predict an individual decision tree. This contributes to higher accuracy and avoids overfitting of the models.

XGBoost: XGBoost is an optimized implementation of advanced decision trees used for supervised learning applications. It iteratively constructs multiple decision trees, where each subsequent tree corrects the errors of the previous one, thus improving the overall predictive performance. It is widely used in data science competitions, industrial applications, and research due to its efficiency, scalability, and effectiveness in handling structured data.

Neural Networks: Neural networks are computational models composed of interconnected nodes, or neurons, organized in layers. Each neuron receives input signals, processes them using activation functions, and produces an output signal. Neural networks are trained using supervised learning techniques, such as backpropagation, to adjust the connections between neurons and optimize the network's performance in specific tasks, such as classification, regression, or pattern recognition. Neural networks are fundamental components of many AI algorithms, including deep learning models.

CNN - Convolutional Neural Networks: Convolutional Neural Networks (CNNs) are a specialized type of neural network architecture designed to process and analyze structured data in the form of grids, such as images or time series data. CNNs employ a hierarchical structure of multiple layers, including convolutional layers, pooling layers, and fully connected layers. Convolutional layers extract features from input data by applying filters, or kernels, across the spatial dimensions of the input, allowing the network to learn hierarchical feature representations at different levels of abstraction. CNNs are widely used in image recognition, object detection, image segmentation, and other computer vision tasks due to their ability to automatically learn relevant features from pixel data.

Multilayer Perceptron (MLP): MLP is a type of feedforward artificial neural network consisting of multiple layers of interconnected neurons. In an MLP, each neuron in one layer is connected to all neurons in the next layer through graphical representations of the relationships between neurons and the propagation of information, forming a directed acyclic graph. MLPs consist of an input layer, one or more hidden layers, and an output layer. They use activation functions to introduce non-

linearity into the network, allowing it to learn complex patterns and relationships within the data. MLPs are commonly used for supervised learning tasks such as classification and regression, where they can approximate complex non-linear functions and make predictions based on input data.

Deep Learning: Deep learning is a subcategory of machine learning that focuses on building and training neural networks with multiple layers to learn intricate patterns and representations from vast amounts of data. These neural networks are composed of interconnected layers of computational units (neurons) that process and transform input data through successive layers to generate increasingly abstract and higher-level representations. Deep learning has achieved notable success in various applications, including image and speech recognition, natural language processing, medical diagnosis, and autonomous driving, among others.

Computer Vision: Computer vision is a field of artificial intelligence that teaches computers to interpret and understand the visual world. It is used for applications such as facial recognition, product inspection on assembly lines, and more.

NLP - Natural Language Processing: Natural Language Processing (NLP) is the application of AI focused on the interaction between computers and humans through natural language. Its goal is to read, decode, understand, and make sense of human language in a meaningful way. It's important to clarify that for natural language processing, one or multiple AI models can be applied for each specific task. Some conversational agents use NLP to understand the user's language and respond or perform specific and predefined actions. In the case of ChatGPT, in addition to interpreting, it will generate a response based on that interpretation.

Transfer Learning: It is a technique in deep learning where a model developed for one task is reused as a starting point for a different model in another task. In other words, it applies the knowledge gained in learning one skill.

Introduction

Sexual, reproductive, and maternal health and rights (SRMH) are an essential component of universal health coverage (UHC). Countries moving towards UHC must implement policies that meet the SRMH needs of their population throughout the life course, from infancy and childhood through adolescence and into adulthood and old age. In this sense, SRMH goals have been included as part of the United Nations Sustainable Development Goals (SDGs) under Goal 3 (targets 3.1 and 3.7) and Goal 5 (target 5.6).[2] Despite the progress made on numerous Development Goals, significant challenges remain in terms of access to quality and affordable care for sexual, reproductive, and maternal health.

Latin America and the Caribbean (LAC) is a region with significant disparities and inequities. These disparities are not only present between countries but also within them. Women who are socially and economically disadvantaged, including those who are young, poor, uneducated, and/or living in rural areas, have the most difficulty obtaining the services they need to prevent unwanted pregnancies, to stay healthy during pregnancy, childbirth, and the postnatal period, and to ensure the health of their newborns. Additionally, highly vulnerable populations that comprise systematically marginalized groups such as: indigenous peoples; Afro-descendants; Lesbians, Gays, Bisexuals, Transgender, Queer, and Intersex individuals (LGBTQI+); people with disabilities; elderly; and migrants, among others, often suffer discrimination and stigmatization that deeply affects their health rights and access to healthcare services. All these conditions of marginality are intensified when they coexist and intersect with each other.

To guarantee universal access to quality SRMH services, it is necessary to consider the specific needs of all populations with an intersectional approach. This implies ensuring that they have accurate and complete information; access to safe, effective, affordable, and acceptable contraceptive methods; are empowered so that they can enjoy a satisfying and risk-free sexual life, protect themselves from sexually transmitted infections (STIs), and, when they decide to have children, can receive healthcare from professionals and access services that help them have safe pregnancies and healthy babies, taking into account the different social, cultural, and personal conditions that determine the diverse realities.

According to data from the United Nations Population Fund (UNFPA), the majority of interventions in sexual and reproductive health are cost-effective. Reducing unintended pregnancies and unsafe abortions, preventing HIV and STI infections, providing affordable contraceptive methods, and offering sexual health counselling are sustainable, low-cost interventions.[3] If investments in sexual and reproductive health services in developing countries are increased and sustained, huge benefits can be achieved. For instance, family planning enables women to reach higher levels of education

and a better balance between family and work. Prenatal care and obstetric services protect the health of the mother and child. Comprehensive Sexual Education is a fundamental resource for empowering young people to make informed and responsible decisions, avoiding unintended pregnancies and STIs. [4]

The convergence between the health sector and technology offers the possibility of leveraging innovative and cost-effective platforms to strengthen local and global capacities, maximizing many of the interventions mentioned above. In recent years, the exponential growth of digital data, the implementation of health information systems, the increase in computing capacity, and advances in programming and coding of artificial intelligence (AI) algorithms have driven digital transformation initiatives. AI offers a wide variety of applications, including machine learning, natural language processing, understanding and generation, speech analysis, conversational virtual agents (chatbots), robotics, and many other tools. These tools can overcome certain limitations by providing efficient and accessible healthcare and contributing to the achievement of Sustainable Development Goals (SDGs) in health.[5]

However, as mentioned in CLIAS's Technical Document 1, in the region, the development of AI in the health sector is still at an exploratory stage, meaning that the criteria for a truly integrated ecosystem are not yet met. This creates challenges in terms of integration and implementation of strategies aimed at covering priority health needs and strengthening health access.

This document **aims to survey and analyse the applications of artificial intelligence tools in the field of sexual health, reproductive health, and maternal health in Latin America and the Caribbean through an exploratory literature review.**

Methodology

The drafting and reporting of the exploratory review presented will use the methodological framework proposed by Arksey and O'Malley.[1] This framework consists of five consecutive stages: 1) Identification of the research question, 2) Identification of relevant studies, 3) Selection of studies, 4) Data extraction, 5) Compilation, summarization, and communication of results. Below, each stage is briefly analysed.

Phase 1: Identification of the Research Question

Arksey and O'Malley suggest an iterative process for developing one or several research questions. After iterations, the researchers identified the following research questions:

- What are the specific themes and/or areas of sexual, reproductive, and maternal health that have been addressed with artificial intelligence in Latin America and the Caribbean? Are they directed at the general population or specific groups?
- What are the most common artificial intelligence tools used in projects related to SRMH in the region?
- What are the development phases of these AI tools?

Phase 2: Identification of Relevant Studies

For the purposes of this exploratory review SRMH was defined broadly, using an adaptation of the WHO framework.[6] Several dimensions are necessary for individuals to achieve SRMH, including access to contraception; safe abortion; prevention, detection, diagnosis, and treatment of STIs, including HIV and AIDS; pregnancy-related care including prenatal care, safe childbirth, and postnatal care; menstrual hygiene; prevention, detection, and management of gynecological conditions and cancers, including cervical cancer; and other relevant dimensions including child or forced marriage, gender-based violence, and gender identity, among others. To identify relevant literature, an exhaustive search strategy was developed, supported by the following inclusion criteria.

Geographical Scope	Latin America and the Caribbean.
AI Terms and Tools	Neural network, machine learning, deep learning, ensemble algorithm, reinforcement learning, closed recurrent unit, autoencoder, multilayer perceptron, convolutional neural network, large linguistic models, transformers, transfer learning, boosted trees, random forests, XGBoost,

	support vector machines, bidirectional encoder representations from transformers (BERT), biomedical, natural language processing, computer vision, word embedding.
Areas of Sexual and Reproductive Health	Reproductive health, contraception, abortion, sexually transmitted infections, human immunodeficiency virus, maternal health, childbirth, postnatal care, reproductive organ cancer, prenatal care, infertility, family planning, comprehensive sexual education, gender-based violence, sexual health.

Artificial intelligence projects applied to health in general, as well as articles addressing the application of artificial intelligence tools in the field of SRMH outside the region of Latin America and the Caribbean, were excluded.

The search was conducted in Spanish and English in the following databases: PubMed, Scielo, Cochrane, and Lilacs with specific search terms (See Annex). Additionally, a targeted search was conducted on Google with each of the terms related to sexual health, reproductive health, and maternal health, and artificial intelligence mentioned above. From the identified articles, a "snowball" strategy was also used to identify other related studies.

Phase 3: Selection of Studies

For the selection of studies, the inclusion and exclusion criteria described above were applied. The selection process for the indexed studies was carried out in two stages. The first consisted of selecting each title and abstract in COVIDENCE by two independent reviewers to determine their eligibility for full-text selection. Each article was classified into one of the following 3 categories (Yes, Maybe, No) to assess relevance and the likelihood of full-text retrieval. In the second phase, all articles, except those categorized as "No" (excluded), were retrieved in full text for further analysis. Disagreements between reviewers were resolved by consensus.

Phase 4: Data Extraction

A data extraction sheet was created in Excel to collect relevant information from the selected articles, including details about the artificial intelligence tool, the sexual and reproductive health service, the country, and other pertinent aspects. The following table represents the suggested information for extraction:

Variable	Description
Search Strategy Used	
Type of Article	Scientific article, journalistic note, report, book, thesis
Authors	
Year of Publication	
Sector	Non-governmental organization (NGO), Private company, Governmental body, Academic institution, International organization, Health organization, Other
Country	
Brief Article Description	
Essential Sexual and Reproductive Health Services [i]	• Accurate information and counseling on sexual and reproductive health including evidence-based, • comprehensive sexual education, counseling and care related to sexual function and satisfaction, • prevention, detection, and management of sexual and gender-based violence, • variety, availability, and access to safe and effective contraceptive method, • safe and effective prenatal, childbirth, and postnatal care, • safe and effective abortion care and services, • prevention, management, and treatment of infertility, • prevention, detection, and treatment of sexually transmitted infections including HIV and reproductive tract infections, • prevention, detection, and treatment of cancers of the reproductive organs
AI Terms and Tools	Neural network, machine learning, deep learning, ensemble algorithm, reinforcement learning, closed recurrent unit, autoencoder, multilayer perceptron, convolutional neural network, large linguistic models, transformers, transfer learning, boosted trees, random forests, XGBoost, support vector machines, bidirectional encoder representations from transformers (BERT), biomedical, natural language processing, computer vision, word embedding
Target Population	
AI Cycle	Laboratory project, Implemented, Implemented with results
Link	

[i] The Guttmacher-Lancet Commission's classification of essential sexual and reproductive health services was used as a reference. https://www.thelancet.com/action/showPdf?pii=S0140-6736%2818%2930293-9

A project was classified as a **laboratory project** when it represents the genesis of new ideas and concepts, marking the start of innovative research that seeks to address specific challenges in SRMH through the application of AI. These projects are often exploratory and descriptive in nature and originate in the academic field.

A project was classified as **implemented** when the tools are operational, although there is no report of results on their performance or efficacy.

A project was classified as **implemented with results** when it offers a more comprehensive evaluation and provides evidence of the effectiveness of the AI tools in the field of SRMH. These tools have generated results that support their performance and contribute to validating their practical utility.

Phase 5: Summary and Reporting of Results

A synthesis of the collected data was performed, providing a numerical description of the included studies, such as the number of studies, type of study/article, years of publication, types of interventions, characteristics of the study populations, countries where the studies were conducted, among others. A thematic analysis of the data was conducted to identify patterns, trends, and emerging themes in the experiences of AI in sexual health, reproductive health, and maternal health in Latin America and the Caribbean. Additionally, the "snowball" strategy was employed to identify additional experiences.

Results

1,518 articles were identified, of which 1,079 (71%) were identified in databases such as PubMed, Scielo, Cochrane, and Lilacs, and 439 (29%) through a search of grey literature and the "snowball" strategy in the references of the articles. After removing duplicates, 1,322 articles were included for screening of titles and abstracts. In this screening, 1,058 studies were excluded, and the eligibility of the remaining 460 was evaluated through full-text review. Of these 460 articles, 143 were included. 121 were excluded for not being AI studies (39), not having been conducted in LAC (49), not studying SRMH (22), or having an inappropriate design (12) (Figure 1).

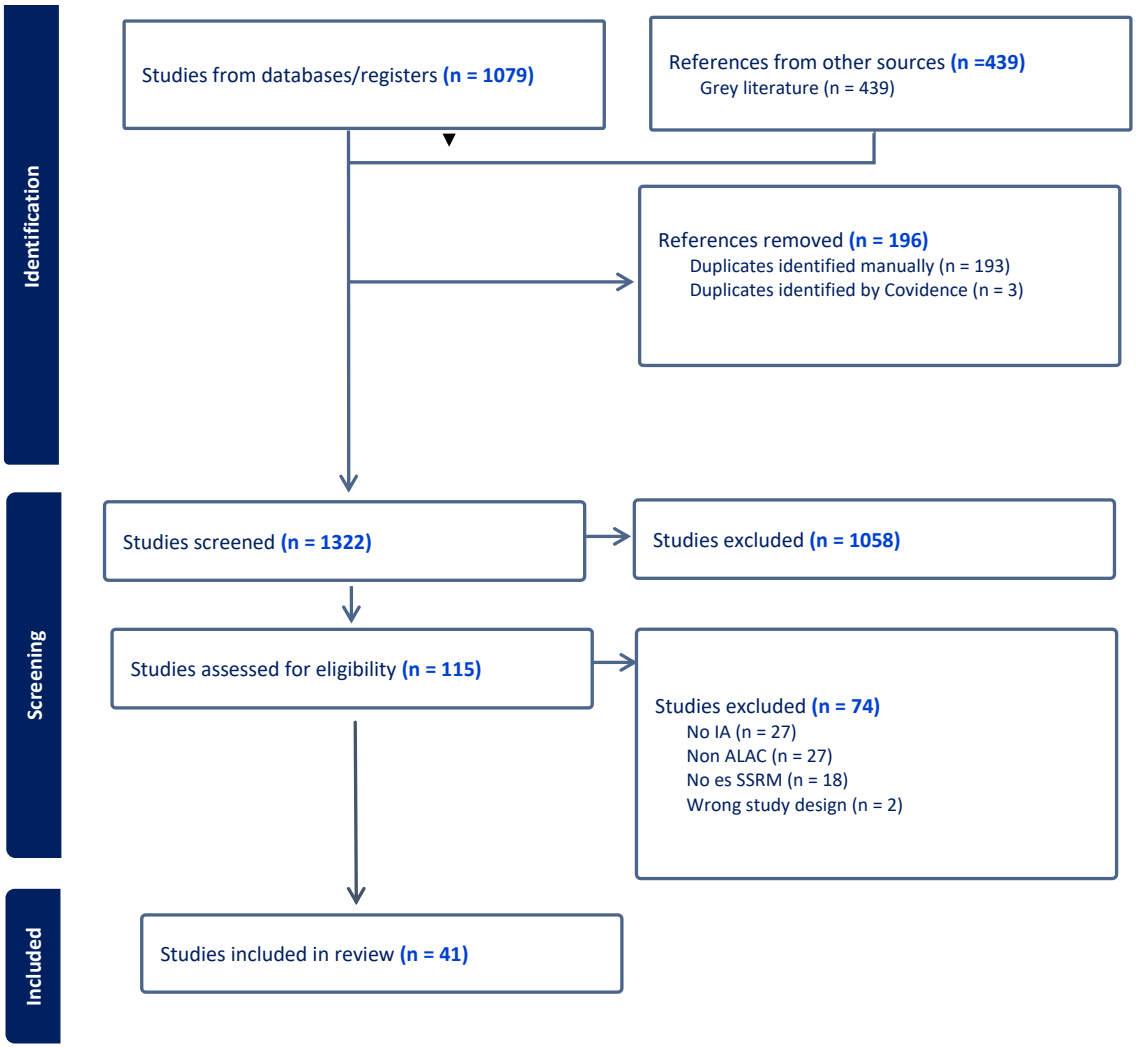


Figure 1. Literature review flowchart.

Characteristics of the Articles

Articles from Mexico (20%, 29/143),[7–35] Colombia (20%, 28/143),[36–62] Perú (17%, 24/143),[63–86] Brazil (10%, 14/143),[87–105] Argentina (10%, 14/143),[106–119] Chile (6%, 9/143),[120–128] Ecuador (3%, 4/143),[129–132] Guatemala (3%, 4/143),[133–136] Cuba (2%, 3/143),[137–139] and Bolivia (1%, 2/143)[140,141] were reviewed. From Nicaragua,[142] Panama,[143] Venezuela,[144] and the Dominican Republic[145] one article per country was included. Finally, 3 articles that applied artificial intelligence in two simultaneous SRMH services were found. [146–148]

It is essential to mention that 78% (112/143) of the selected articles are national productions, while 22% (31/143) are of international origin analysing AI and SRMH experiences in one or more countries of LAC.

Regarding the temporal period of the selected articles, publications ranging from the year 2007 to 2023 were identified. The majority (76%, 109/143) are concentrated in the last four years, between 2020 and 2023.

54% (77/143)[10,16,17,22–35,37,40,42,53,57,58,60,62,64,65,70–73,79,81,84–91,93–107,112,119,126–128,133–136,138–141,143,144,146–151] of the selected articles are scientific articles published in academic-scientific journals and are indexed in virtual libraries.

Additionally, 43 university theses at the undergraduate and graduate levels were identified, representing 30% of the total.[7–9,13,18–21,24,36,38,39,44–50,52,54–56,63,66–69,74–78,117,121,122,124,129–132,137] Within the field of health sciences, 6 theses were found (14%), while the remaining 86% (37/43) belong to the engineering field -in systems, electronics, computational, software, etcetera-. Also, 21 (15%) [11,12,15,41,43,59,80,83,108–111,113–116,118,120,123,125,145,152–156] internet notes published on various journalistic portals of organizations or companies were found. Finally, a book and a report were reviewed.

Regarding gender representation in the authorship of the reviewed articles, it is highlighted that 61% (47/77) [10,17,22,23,25–28,30–35,40,53,57,58,60,61,65,71–73,79,84,86,88,93,95–101,103,104,107,119,127,128,135,138,143,144,147] of the research papers published in scientific journals have a man as the responsible or corresponding author, compared to 29% (22/77) [16,29,62,70,81,82,87,89–92,94,102,105,106,133,134,136,140,141,146,148] where a woman is listed as the corresponding author. To determine the distribution of roles by gender, the list of authors and the "Author Contributions" section in each article were reviewed.

Research Question 1: Essential Sexual and Reproductive Health Services Addressed with Artificial Intelligence in the Region

The application of artificial intelligence is mainly highlighted in effective prenatal, childbirth, and postnatal care (36%, 52/143),[12,21,22,27,29–33,38–42,56,62,65–68,79,85,86,88,90–93,95–98,100,104–107,110,112,121,124,126–

[128,132–136,143,148–150,153,157] followed by the prevention, detection, and treatment of reproductive organ cancers (31%, 45/143).[7,13–20,24,28,43–55,69–78,82,111,114,116,122,123,130,138,139,144,147,151,156,158]

In terms of percentage, the rest of the articles are similarly distributed across various SRMH areas. These include the prevention, detection, and management of sexual and gender-based violence (8%, 12/143);[23,57,63,64,80,87,113,115,117,131,145,146] the prevention, management, and treatment of infertility (8%, 11/143);[25,26,34,35,60,84,94,102,103,108,119] as well as the prevention, detection, and treatment of sexually transmitted infections including HIV and reproductive tract infections (6%, 9/143).[8–10,36,37,120,125,137,140,152]

3% (4/143)[58,59,81,114] of the selected articles study the application of artificial intelligence to provide accurate and counselling on sexual and reproductive health, including evidence-based comprehensive sexual education. 2% (3/143) [83,118,141] are dedicated to implementing this technology to offer information, counselling, and care related to sexual function and satisfaction. Similarly, 2% (3/143) [99,109,142] of the studies focus on the application of AI to facilitate the choice of safe and effective contraceptive methods.

Finally, two articles focusing on the application of artificial intelligence to address congenital syphilis, covering two fundamental areas: safe and effective prenatal, childbirth, and postnatal care as well as the prevention, detection, and treatment of sexually transmitted infections were identified.[89,101]

Regarding the target population, a significant proportion of AI tools are directed at the care of pregnant individuals (36%, 51/143),[12,21,22,27,29–32,38–42,56,62,65–68,79,85,86,88–93,95–98,100,101,104–107,110,112,121,124,126–128,132–134,136,143,148] followed by individuals with cancer (31%, 45/143).[7,13–20,24,28,43–55,69–78,82,111,116,122,123,130,138,139,144,147] The third place is occupied by articles whose central population are women [11,23,57,61,63,64,94,99,108,114,117,131,142,146] and the general population [25,33–35,83,84,87,102,103,113,115,118,129,141] (11%, 16/143 y 8%, 12/143 respectively). The general population with HIV+ or other sexually transmitted infections is represented in 6% of the articles (9/143) [8–10,36,37,120,125,137,140] and the development of AI solutions for children and adolescents was identified in seven articles (5%).[58,59,80,81,109,112,145] Lastly, the application of AI in SRMH services specifically directed at men is limited, with three articles identified (2%). [26,60,119]

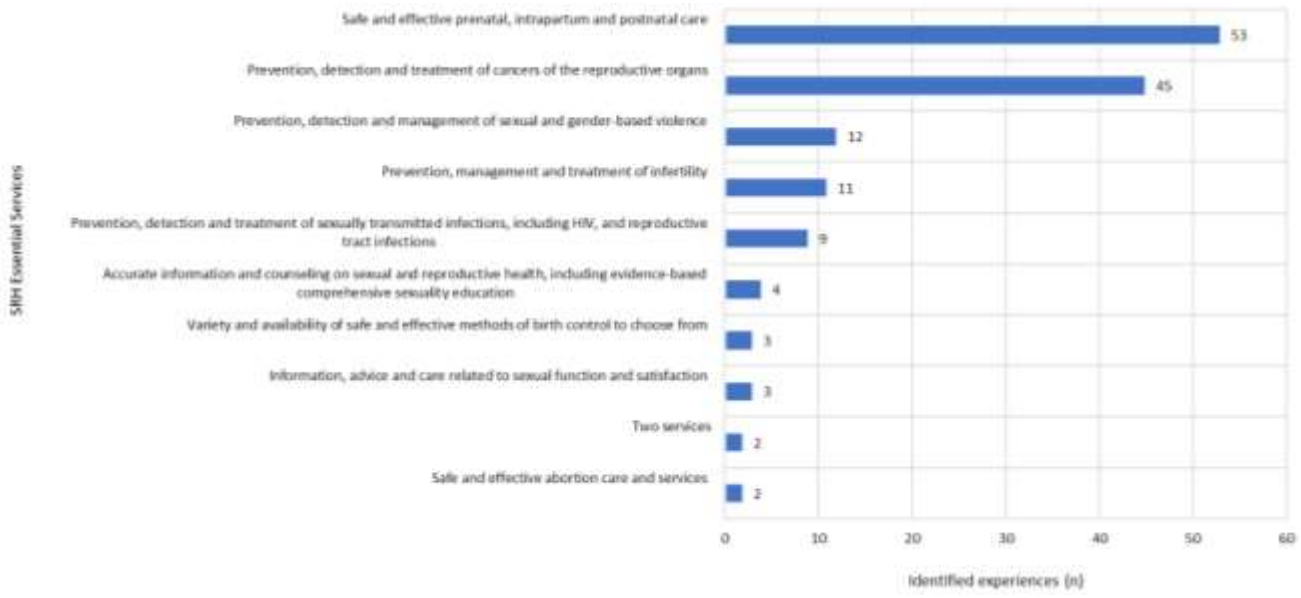


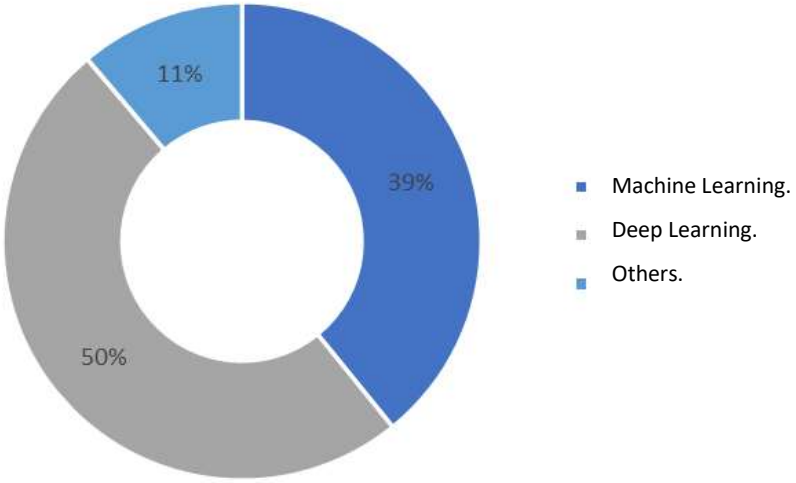
Figure 2 Number of AI experiences surveyed by essential SRH service

Research Question 2: Artificial Intelligence Tools Used in Sexual and Reproductive

To effectively categorize artificial intelligence tools, it is important to consider multiple dimensions, such as the models used, training strategies, and application areas. In this context, those articles that use neural networks are distinguished from those that do not, allowing them to be grouped into experiences based on Deep Learning and Machine Learning techniques, respectively.

In the analysis, 73 articles that use Machine Learning techniques were identified, representing 51% of the total.[10,13,24,27,30,32,34,35,37–39,42,45,48,49,51,54,57,59,61,65,66,68,70,71,74,84,87,89,92–94,98–100,102,104,108–110,112–115,117,119–121,126–130,137,138,140,142,143,146,148,159,160] Within this category, Support Vector Machines, Random Forests, and those applying XGBoost stand out. On the other hand, 58 articles that employ Deep Learning techniques, constituting 39% of the total reviewed articles, were identified.[7–9,16–19,21,23,24,26,28,29,31,32,36,41,43,44,46,47,53,55,56,58,60,62–64,67,69,72,73,75,76,78,79,85,86,88,95,103,105,106,111,116,122,131–136,139,144,147] For example, through the use of Convolutional Neural Networks, Artificial Neural Networks, and Multilayer Perceptron to a lesser extent.

Furthermore, experiences not specifying the AI technique and described according to the task to be solved or application area were found. For instance, seven articles focused on Natural Language Processing [81,83,90,96,97,118,141] and three articles implementing Computer Vision were identified.[11,15,25] Two other articles address artificial intelligence in a more general sense without mentioning a specific technique or application area used.[33,91]

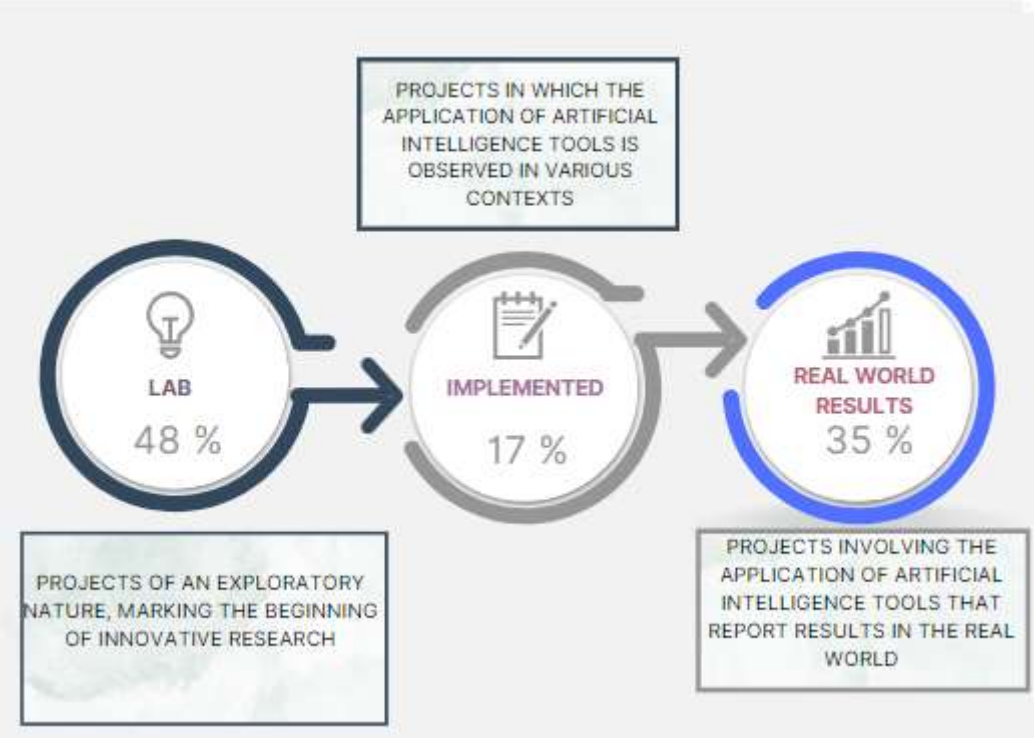


Research Question 3: Development Phases of AI Tools

According to the predefined categories, a large number of "laboratory projects" (48%, 68/143) were found.[7–10,13–21,24,26,33,36,38–41,43–47,49–52,54–57,60–63,66,68,69,72–78,84,87,103,104,117–119,121,122,124,129 132,137,143,144,146,148] This category includes almost all the degree theses and some scientific articles.

In the "implemented projects" category, various artificial intelligence tools demonstrating their utility in real-life settings (17%, 25/143) were identified.[11,12,25,48,58,59,67,79,80,83,99,102,108–111,113–116,120,123,125,138,145] This group includes articles that still lack a formal report of results, though there is knowledge of their practical application in various contexts.

Lastly, 50 articles whose AI tools are implemented and report results on their performance were reviewed (35%, 50/143).[22,23,27–32,34,35,37,42,53,64,65,70,71,81,82,85,86,88–98,100,101,105–107,112,126–128,133–136,139–142,147]


PROJECTS IN WHICH THE APPLICATION OF ARTIFICIAL INTELLIGENCE TOOLS IS OBSERVED IN VARIOUS CONTEXTS
LAB
48 %
IMPLEMENTED
17 %
REAL WORLD RESULTS
35 %
PROJECTS OF AN EXPLORATORY NATURE, MARKING THE BEGINNING OF INNOVATIVE RESEARCH
PROJECTS INVOLVING THE APPLICATION OF ARTIFICIAL INTELLIGENCE TOOLS THAT REPORT RESULTS IN THE REAL WORLD

Discussion

The majority of the studies reviewed were published recently, between 2020 and 2023. This is not surprising considering the exponential growth of accessible data, the greater computational capacity available, and advancements in methodological aspects. However, as will be detailed later, it is highlighted that most of the artificial intelligence solutions applied to sexual, reproductive, and maternal health are of an exploratory nature and present significant methodological limitations.

In line with this observation, despite identifying scientific articles, **the review of the grey literature reveals a significant number of tools and projects that are not published in indexed databases**. This is especially evidenced through a high number of degree theses and internet notes reviewed.

On the other hand, when observing gender representation, a clear disparity in authorship roles within the scientific-academic production on the topic is evident. **Although women's representation in research teams is limited, an increase in recent years is observed, reflecting growth in their participation in generating knowledge in this specific field**. This phenomenon underscores the importance of promoting and supporting gender diversity in research on artificial intelligence applied to sexual, reproductive, and maternal health, as well as strengthening women's training in these knowledge fields.

The review shows a clear orientation towards artificial intelligence projects in specific areas of SRMH. **The application of AI in prenatal care and addressing diseases like reproductive organ cancers is highlighted**. However, abortion care services and counseling related to sexual satisfaction and function are underrepresented, **noting a predominance towards reproductive and maternal health over sexual health.**

The scarcity of AI projects and tools applied to sexual health could be attributed to various reasons. In many countries in the region, there are political, cultural, organizational, economic, and geographical barriers that hinder access to these services. For example, except in Argentina, Colombia, Cuba, Guyana, Uruguay, and Mexico, where abortion is decriminalized under certain conditions, such as risk to the life of the pregnant person, rape, or fetal inviability, in most Latin American and Caribbean countries, abortion is criminalized. In some countries, such as Nicaragua, Honduras, the Dominican Republic, and El Salvador, this practice is prohibited under any circumstances. Similarly, in some regions, gender diversity and comprehensive sexual education are also approached with reluctance, considering them taboo.

The application of artificial intelligence solutions in essential sexual and reproductive health services has a diverse distribution concerning the target population. Knowing the specific population these tools are applied to allows for a more complete understanding of the diversity of approaches and

populations involved in the projects. As mentioned earlier**, it is crucial to pay special attention to minority groups and people in more vulnerable conditions, considering their specific needs to promote appropriate access to health services.**

In line with the predominance of AI tools applied to prenatal care and the prevention and treatment of cervical cancer**, the target population of most studies are pregnant people and individuals with cancer**.

In recognizing artificial intelligence tools in the area of SRMH, we observe a diverse and constantly evolving landscape. It is noteworthy that from models based on knowledge representation through specific symbolic rules that facilitate interpretation and decision-making based on predefined criteria to sophisticated machine learning and deep neural networks approaches with generative capabilities. These latter stand out for their ability to analyze and synthesize large volumes of data, learning complex patterns and providing an understanding that goes beyond traditional methods, opening avenues for accurate diagnostics, personalized treatments, and proactive approaches in reproductive health. These tools have been developed with various objectives, reflecting the complexity and heterogeneity of needs in this field.

Among the objectives in developing AI tools are diagnostic and prediction systems, where advanced algorithms are used to enhance diagnostic accuracy in conditions such as endometriosis or pregnancy complications. These systems often use machine learning to analyze medical images or clinical data, improving early detection and treatment personalization.

Likewise**, educational and awareness platforms employ interactive AI, including chatbots and mobile applications,** to provide accessible and personalized information on sexual and reproductive health, aiming to understand language and provide comprehensible information to the target population. These tools play a crucial role in educating youths and vulnerable groups, offering a safe space for learning and asking questions.

Furthermore**, monitoring and follow-up through AI-driven devices and applications allow continuous tracking of reproductive health indicators**, such as menstrual cycles or fetal development, facilitating early anomaly detection and promoting proactive health management.

Evaluating the development phases of artificial intelligence tools in the field of SRMH is essential for a comprehensive view of their maturity and effectiveness. Understanding these stages not only facilitates the grasp of the current research landscape but also accounts for the opportunity areas and gaps that could be addressed in future projects and academic studies.

As previously mentioned**, a large number of articles represent new ideas (laboratory projects), marking the start of innovative research** that seeks to address specific challenges in SRMH through the application of AI. Given the exploratory nature of these projects, there is a need to develop more

robust methodologically sound studies and new research that not only consolidate preliminary findings but also employ more solid methodologies to determine the true utility of the designed technology.

Regarding projects that are implemented, the application of AI **tools is observed in various contexts, such as health centers, radiology or diagnostic imaging services, and educational settings like schools and universities**. Specifically, in the school environment, applications are focused on providing information to adolescents and youths about contraceptive methods and sexual health in general. Meanwhile, in diagnostic imaging services, AI solutions aim to improve early disease detection, contributing to a more accurate prognosis.

Concerning projects whose AI tools report results about their performance or efficacy, some reflections arise. **Despite the exponential growth of data and the development of tools to address sexual, reproductive, and maternal health challenges, it raises the question: for example, does an adequate performance of a statistical model necessarily improve access to and quality of medical care?** Specifically, how do these technical performances translate into significant changes in health outcomes for users? Do AI tools, despite their technical efficacy, impact health professionals' decision-making and actions in their daily practice? The answers to these questions open an unlimited field for research, outlining a knowledge space that requires more detailed exploration and exceeds this study.

Regarding the limitations of this study, it is crucial to highlight that the primary information source comes from data available on the internet, particularly information published in scientific journals or academic sites. This presents at least two significant limitations. On one hand, not all online information is up-to-date or complete, especially regarding developments and applications of artificial intelligence, as there may be projects or advances that are not published in scientific journals. Additionally, some areas of interest within the field of SRMH might be underrepresented due to lesser visibility.

Another limitation to consider is that the research team is mainly composed of members from Argentina. This bias could influence the identification of projects, research, and AI applications in SRMH in other Latin American and Caribbean countries, particularly in the search for grey literature, leading to a possible underrepresentation of these developments in the region.

Furthermore, it is crucial to note that the search was conducted in Spanish and English, excluding Portuguese. This might have left out relevant developments and projects in artificial intelligence and sexual health, reproductive health, and maternal health in Brazil, resulting in an underrepresentation of these initiatives.

Conclusions

This study has deeply explored the application of artificial intelligence in sexual health, reproductive health, and maternal health in Latin America and the Caribbean. We have identified that although there is significant progress, especially in areas such as prenatal care and the prevention of cervical cancer, there are still considerable gaps and challenges. The findings underscore the need to focus on the diversification of AI applications and the inclusion of diverse populations to ensure equitable and effective access to reproductive and sexual health services.

Analysing the use of AI tools in SRMH highlights the gap between the sector's needs and the current AI solutions. This leads us to raise crucial questions for future research: Are advances in timely diagnoses through AI accompanied by access to timely treatments, such as in cases of gestational diabetes or preeclampsia? Do we have effective strategies to act upon an early diagnosis of breast cancer, for example? These questions underline the importance of, on one hand, generating regulations and normative frameworks that delineate the scenario and coordinate the development of AI solutions to health problems in a strategic manner, and on the other hand, aligning technological innovations with the real and emerging needs in sexual health, reproductive health, and maternal health, ensuring that AI not only identifies problems but also contributes to comprehensive and effective solutions.

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Annex

Table 1. Search strategy

PUBMED	(Artificial Intelligence[Mesh] OR Artificial Intelligence*[tiab] OR AI[tiab] OR Virtual Intelligence*[tiab] OR Automated Technique*[tiab] OR Machine Learning[Mesh] OR Machine Learning[tiab] OR Transfer Learning[tiab] OR Deep Learning[tiab] OR Neural Networks, Computer[Mesh] OR Neural Network*[tiab] OR Deep Convolutional[tiab] OR CNN[tiab] OR Random Forest[Mesh] OR Random Forest*[tiab] OR Support Vector[tiab] OR Computer Vision[tiab]) AND (Family Planning Services[Mesh] OR Family Planning[tiab] OR Contraception[Mesh] OR Contracept*[tiab] OR Infertility[Mesh] OR Infertility[tiab] OR Sterility[tiab] OR Reproductive Health*[tiab] OR Acquired Immunodeficiency Syndrome[Mesh] OR AIDS[tiab] OR Immunodeficiency Syndrome[tiab] OR Immuno-Deficiency Syndrome[tiab] OR Pregnancy[Mesh] OR Pregnan*[tiab] OR Sexual Health[Mesh] OR Sexual Health*[tiab] OR Gender-Based Violence[Mesh] OR “Gender Violence"[tiab] OR Mental Health[Mesh] OR Mental Health*[tiab] OR Pre-Eclampsia[Mesh] OR Pre-Eclampsia[tiab] OR Preeclampsia[tiab] OR Depression, Postpartum[Mesh] OR Postpartum Depression[tiab] OR Postnatal Depression[tiab] OR Postnatal Dysphoria[tiab] OR Postpartum Dysphoria[tiab]) AND (Americas[Majr] OR Latin America[Mesh] OR Latin America*[tiab] OR Latinamerica*[tiab] OR Latinoamerica*[tiab] OR Hispanoamerica*[tiab] OR Iberoamerica*[tiab] OR Ibero Americ*[tiab] OR Panamerican*[tiab] OR Central America[Mesh] OR Central America*[tiab] OR Centroamerica*[tiab] OR Mesoamerica*[tiab] OR Meso America*[tiab] OR Middle America*[tiab] OR South America[Mesh] OR South America*[tiab] OR Southamerica*[tiab] OR Sudamerica*[tiab] OR "America del Sur"[tiab] OR Caribbean Region[Mesh] OR Caribbean[tiab] OR Caribe*[tiab] OR West Indies[Mesh] OR West Indi*[tiab] OR Antill*[tiab] OR Indians, South American[Mesh] OR Indians, Central American[Mesh] OR Amerindian*[tiab] OR Indians[tiab] OR American Indian*[tiab] OR Native America*[tiab] OR Patagoni*[tiab] OR Andes[tiab] OR Andean*[tiab] OR Amazon*[tiab] OR Anguilla[ad] OR Anguill*[tiab] OR Anguilla[pl] OR "Antigua and Barbuda"[ad] OR "Antigua and Barbuda"[tiab] OR "Antigua and Barbuda"[pl] OR Argentin*[ad] OR Argentin*[tiab] OR Argentina[pl] OR Bahama*[ad] OR Baham*[tiab] OR Bahama*[pl] OR Bermud*[ad] OR Bermud*[tiab] OR Bermud*[pl] OR Bolivia*[ad] OR Bolivia*[tiab] OR Bolivia[pl] OR Brazil*[ad] OR Brasil*[ad] OR Brazil*[tiab] OR Brasil*[tiab] OR Brazil[pl] OR Colombia*[ad] OR Colombia*[tiab] OR Colombia[pl] OR Chile*[ad] OR Chile*[tiab] OR Chile[pl] OR Ecuador*[ad] OR Ecuator*[ad] OR Ecuador*[tiab] OR Ecuador[pl] OR Guiana*[ad] OR Guiana*[tiab] OR French Guiana[pl] OR Guyan*[ad] OR Guyan*[tiab] OR Guyana[pl] OR Paraguay*[ad] OR Paraguay*[tiab] OR Paraguay[pl] OR Peru*[ad] OR Peru*[tiab] OR Peru[pl] OR Surinam*[ad] OR Surinam*[tiab] OR Surinam*[pl] OR Uruguay*[ad] OR Uruguay*[tiab] OR Uruguay[pl] OR Venez*[ad] OR Venez*[tiab] OR Venezuela[pl]

	OR Belize*[ad] OR Belize*[tiab] OR Belize[pl] OR Costa Ric*[ad] OR Costarric*[ad] OR Costaric*[ad] OR Costa Ric*[tiab] OR Costarric*[tiab] OR Costaric*[tiab] OR Costa Rica[pl] OR Salvador*[ad] OR Salvador*[tiab] OR El Salvador[pl] OR Guatemal*[ad] OR Guatemal*[tiab] OR Guatemala[pl] OR Hondur*[ad] OR Hondur*[tiab] OR Honduras[pl] OR Nicaragu*[ad] OR Nicaragu*[tiab] OR Nicaragua[pl] OR Panam*[ad] OR Panam*[tiab] OR Panama[pl] OR Mexico[Mesh] OR Mexic*[ad] OR Mexic*[tiab] OR Mejic*[tiab] OR Mexico[pl] OR Cuba*[ad] OR Cuba*[tiab] OR Cuba[pl] OR Dominic*[ad] OR Dominic*[tiab] OR Dominican Republic[pl] OR Haiti*[ad] OR Haiti*[tiab] OR Haiti[pl] OR Jamaic*[ad] OR Jamaic*[tiab] OR Jamaica[pl] OR Puerto Rico[Mesh] OR Puerto Ric*[tiab] OR Puertorric*[tiab] OR Puertoric*[tiab])
LILACS	(MH Artificial Intelligence OR ((Artificial OR Virtual) AND (Intelligence$ OR Inteligencia)) OR AI OR IA OR ((Machine OR Automático OR Maquina OR Deep) AND (Learning OR Aprendiza$ OR Transfer OR Profundo OR Convolutional OR Convolucional)) OR MH Neural Networks, Computer OR ((Red OR Network OR Rede) AND (Neural OR Neuronal)) OR CNN OR MH Random Forest OR ((Random OR Aleatori$) AND (Forest OR Bosque OR Floresta)) OR ((Vector OR Vetor) AND (Support OR Soporte OR Apoio)) OR ((Comput$) AND (Vision OR Visao))) AND (MH Family Planning Services OR ((Family OR Familiar) AND (Planning OR planificación OR Planejamento)) OR MH Contraception OR Contracept$ OR Anticoncep$ OR MH Infertility OR Infertili$ OR Esterili$ OR ((Reproductiv$) AND (Salud OR Saude OR Health$)) OR MH Acquired Immunodeficiency Syndrome OR SIDA OR ((Immunodeficien$ OR Inmunodeficien$ OR Imunodeficien$) AND (Syndrome OR Sindrome)) OR MH Pregnancy OR Pregnan$ OR Embaraz$ OR Gravid$ OR MH Sexual Health OR ((Sexual OR Mental) AND (Health OR Salud OR Saude)) OR MH Mental Health OR MH Gender-Based Violence OR ((Violenc$) AND (Gender OR Género)) OR MH Pre-Eclampsia OR Eclampsia OR Preeclampsia OR MH Depression, Postpartum OR ((Depres$ OR Dysphoria OR Disforia) AND (Postpart$ OR Postnatal))) [Words] and 2018 OR 2019 OR 2020 OR 2021 OR 2022 OR 2023 [Country, year publication]
SCIELO	(((Artificial OR Virtual) AND (Intelligence$ OR Inteligencia)) OR AI OR IA OR ((Machine OR Automático OR Maquina OR Deep) AND (Learning OR Aprendiza$ OR Transfer OR Profundo OR Convolutional OR Convolucional)) OR ((Red OR Network OR Rede) AND (Neural OR Neuronal)) OR CNN OR ((Random OR Aleatori$) AND (Forest OR Bosque OR Floresta)) OR ((Vector OR Vetor) AND (Support OR Soporte OR Apoio)) OR ((Comput$) AND (Vision OR Visao))) **AND** (((Family OR Familiar) AND (Planning OR Planificación OR Planejamento)) OR Contracept$ OR Anticoncep$ OR Infertili$ OR Esterili$ OR ((Reproductiv$) AND (Salud OR Saude OR Health$)) OR SIDA OR ((Immunodeficien$ OR Inmunodeficien$ OR Imunodeficien$) AND (Syndrome OR Sindrome)) OR Pregnan$ OR Embaraz$ OR Gravid$ OR ((Sexual OR Mental) AND (Health OR Salud OR Saude)) OR ((Violenc$) AND (Gender OR Género)) OR MH Pre-Eclampsia OR Eclampsia OR Preeclampsia OR ((Depres$ OR Dysphoria OR Disforia) AND (Postpart$ OR Postnatal))) AND (year_cluster:(2018 OR 2019 OR 2020 OR 2021 OR 2022 OR 2023)) (**MH Artificial Intelligence** OR ((Artificial OR Virtual) AND (Intelligence$ OR Inteligencia)) OR AI OR IA OR ((Machine OR Automático OR Maquina OR Deep) AND (Learning OR Aprendiza$ OR Transfer OR Profundo OR Convolutional OR

	Convolucional)) OR **MH Neural Networks, Computer** OR ((Red OR Network OR Rede) AND (Neural OR Neuronal)) OR CNN OR **MH Random Forest** OR ((Random OR Aleatori$) AND (Forest OR Bosque OR Floresta)) OR ((Vector OR Vetor) AND (Support OR Soporte OR Apoio)) OR ((Comput$) AND (Vision OR Visao))) **AND** (**MH Family Planning Services** OR ((Family OR Familiar) AND (Planning OR planificación OR Planejamento)) OR **MH Contraception** OR Contracept$ OR Anticoncep$ OR **MH Infertility** OR Infertili$ OR Esterili$ OR ((Reproductiv$) AND (Salud OR Saude OR Health$)) OR **MH Acquired Immunodeficiency Syndrome** OR SIDA OR ((Immunodeficien$ OR Inmunodeficien$ OR Imunodeficien$) AND (Syndrome OR Sindrome)) OR **MH Pregnancy** OR Pregnan$ OR Embaraz$ OR Gravid$ OR **MH Sexual Health** OR ((Sexual OR Mental) AND (Health OR Salud OR Saude)) OR **MH Mental Health** OR **MH Gender-Based Violence** OR ((Violenc$) AND (Gender OR Género)) OR MH Pre-Eclampsia OR Eclampsia OR Preeclampsia OR **MH Depression, Postpartum** OR ((Depres$ OR Dysphoria OR Disforia) AND (Postpart$ OR Postnatal)))
COCHRANE	MH Artificial Intelligence OR (Artificial NEAR/1 Intelligence*):ti,ab,kw OR AI:ti,ab,kw OR (Virtual NEAR/1 Intelligence*):ti,ab,kw OR (Automated NEAR/1 Technique*):ti,ab,kw OR MH Machine Learning OR (Machine NEAR/1 Learning):ti,ab,kw OR (Transfer NEAR/1 Learning):ti,ab,kw OR (Deep NEAR/1 Learning):ti,ab,kw OR MH Neural Networks, Computer OR (Neural NEAR/1 Network*):ti,ab,kw OR (Deep NEAR/1 Convolutional):ti,ab,kw OR CNN:ti,ab,kw OR MH Random Forest OR (Random NEAR/1 Forest*):ti,ab,kw OR (Support NEAR/1 Vector):ti,ab,kw OR (Computer NEAR/1 Vision):ti,ab,kw AND MH Family Planning Services OR (Family NEAR/1 Planning):ti,ab,kw OR MH Contraception OR Contracept*:ti,ab,kw OR MH Infertility OR Infertility:ti,ab,kw OR Sterility:ti,ab,kw OR (Reproductive NEAR/1 Health*):ti,ab,kw OR MH Acquired Immunodeficiency Syndrome OR AIDS:ti,ab,kw OR (Immunodeficiency NEAR/1 Syndrome):ti,ab,kw OR MH Pregnancy OR Pregnan*:ti,ab,kw OR MH Sexual Health OR (Sexual NEAR/1 Health*):ti,ab,kw OR MH Gender-Based Violence OR (Gender NEAR/1 Violence):ti,ab,kw OR MH Mental Health OR (Mental NEAR/1 Health):ti,ab,kw OR MH Pre-Eclampsia OR Pre-Eclampsia:ti,ab,kw OR Preeclampsia:ti,ab,kw OR MH Depression, Postpartum OR (Postpartum NEAR/1 Depression):ti,ab,kw OR (Postnatal NEAR/1 Depression):ti,ab,kw OR (Postnatal NEAR/1 Dysphoria):ti,ab,kw OR (Postpartum NEAR/1 Dysphoria):ti,ab,kw AND MJ Americas OR MH Latin America OR (Latin NEAR/1 America*) OR Latinamerica* OR Latinoamerica* OR Latin* OR Hispanic Americans OR Iberoamerica* OR (Ibero NEAR/1 Americ*) OR Panamerican* OR (Central NEAR/1 America*) OR Centroamerica* OR Mesoamerica* OR (Meso NEAR/1 America*) OR (Middle NEAR/1 America*) OR (South NEAR/1 America*) OR Southamerica* OR Sudamerica* OR (America NEAR/1 Sur) OR Caribbean OR Caribe* OR (West NEAR/1 Indi*) OR Antill* OR Amerindian* OR Indians OR (American NEAR/1 Indian*) OR (Native NEAR/1 America*) OR Patagoni* OR Andes OR Andean* OR Amazon* OR MH Argentina OR Argentin* OR MH Bolivia OR Bolivia* OR MH BRazil OR Brazil* OR Brasil* MH Colombia OR Colombia* OR MH Chile OR Chile* OR MH Ecuador OR Ecuador* OR MH Guiana OR Guiana* OR Guyan* OR MH Paraguay OR Paraguay* OR MH Peru OR Peru* OR MH Suriname OR Surinam* OR MH Uruguay OR Uruguay* OR MH Venezuela OR Venez* OR MH Belize OR Belize* OR MH Costa Rica OR (Costa NEAR/1 Ric*) OR Costarric* OR Costaric* OR (Costa NEAR/1 Ric*) OR Costarric* OR MH

	Salvador OR Salvador* OR MH Guatemala OR Guatemal* OR MH Honduras OR Hondur* OR MH Nicaragua OR Nicaragu* OR MH Panama OR Panam* OR MH Mexido OR Mexic* OR MH Cuba OR Cuba* OR MH Dominican Republic OR Dominic* OR MH Haiti OR Haiti* OR MH Jamaca OR Jamaic* OR MH Puerto Rico OR (Puerto NEAR/1 Ric*) OR Puertorric* OR Puertoric* with Publication Year from 2018 to 2023, with Cochrane Library publication date Between Jan 2018 and Aug 2023, in Trials
GOOGLE	"Planificación familiar"+ ("Multilayer Perceptron" OR "Convolutional Neural Network" OR "Large Language Models" OR "Transformers" OR "Transfer Learning" OR "Boosted Trees" OR "Random Forests" OR "XGBoost" OR "Support Vector Machines" OR "Bidirectional Encoder Representations from Transformers" OR "Biomedical BERT" OR "Natural Language Processing" OR "Computer Vision" OR "Word Embeddings" OR "Inteligencia Artificial" OR "Inteligencia Artificial en Atención Médica" OR "Salud Digital" OR "e-Salud" OR "Red Neuronal" OR "Aprendizaje Automático" OR "Aprendizaje Profundo" OR "Algoritmo de Conjunto" OR "Aprendizaje por Reforzamiento" OR "Unidad de Recurrencia Enrejada" OR "Autoencoder" OR "Perceptrón Multicapa" OR "Red Neuronal Convolucional" OR "Modelos de Lenguaje Grandes" OR "Transformadores" OR "Transferencia de Aprendizaje" OR "Árboles Reforzados" OR "Bosques Aleatorios" OR "XGBoost" OR "Máquinas de Vectores de Soporte" OR "Codificadores de Transformador Bidireccionales" OR "BERT Biomédico" OR "Procesamiento del Lenguaje Natural" OR "Visión por Computadora" OR "Incrustaciones de Palabras") Infertilidad Salud reproductive Anticoncepción Educación Sexual Integral Violencia de género Salud sexual Aborto Infecciones de transmisión sexual VIH Salud materna Parto Cuidado posnatal Cáncer del sistema reproductivo Cáncer de mama Cáncer uterino Cáncer de útero Cáncer de cervix Cáncer ginecológico Cuidado prenatal Embarazo

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