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## **Big Data in decision-making processes relating to sexual and reproductive health: practical case studies of midwives in the Democratic Republic of the Congo**

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### **Abstract**

Sexual and reproductive health is a major public health issue in the Democratic Republic of the Congo (DRC), characterised by high maternal mortality rates and inequalities in access to care. In this context, midwives play a central role in the care of women and newborns. However, their practices remain poorly modelled and insufficiently utilised to support decision-making.

This article explores the contribution of Big Data to improving decision-making in reproductive health through the modelling of midwives' practices in the DRC. Using a mixed-methods approach combining big data analysis, field surveys and predictive modelling, the study highlights the potential of analytical technologies to improve the quality of care.

The results show that integrating clinical, demographic and behavioural data enables the prediction of obstetric risks, the optimisation of midwives' interventions and the strengthening of health planning.

**Keywords:** Big Data, reproductive health, processes, midwives, decision support, DRC, artificial intelligence, modelling, public health.

### **1. Introduction**

The digital transformation of the healthcare sector has fostered the emergence of Big Data as a strategic lever for improving healthcare systems. Big Data is characterised by the volume, variety and velocity of data generated within healthcare systems. In developing countries such as the DRC, challenges related to maternal health remain a cause for concern. It is estimated that three women die every hour from causes related to pregnancy or childbirth. In this context, the integration of Big Data into midwives' practices can improve the quality of clinical and strategic decisions.

Over the past few decades, the rapid evolution of information and communication technologies has profoundly transformed healthcare systems worldwide. The emergence of Big Data, characterised by massive volumes of data, a wide variety of formats and high-speed generation, now offers new opportunities to improve the quality of care and strengthen decision-making processes. In this context, the intelligent use of data is becoming a strategic lever for guiding health policies and optimising professional practices.

In the field of sexual and reproductive health, the availability and analysis of data play a crucial role in prevention, diagnosis and patient care. In fact, in the field of sexual and reproductive health, information derived from consultations, medical records, awareness campaigns and health surveillance systems forms an essential basis for understanding the needs of

populations and tailoring interventions. The integration of Big Data in this field thus enables a shift from a reactive to a proactive approach, based on predictive analysis and decision support.

In the Democratic Republic of the Congo, midwives play a central role in the healthcare system, particularly in the areas of antenatal care, childbirth and postnatal care. However, they often face major challenges such as a lack of resources, insufficient digital tools and difficulty accessing reliable and up-to-date data. The introduction of Big Data-based technologies could help improve their professional practices by facilitating the collection, analysis and use of health data.

This article therefore aims to analyse the role of Big Data in decision-making regarding sexual and reproductive health, with a particular focus on the practices of midwives in the Democratic Republic of the Congo. In particular, it examines how data can be used to improve the quality of care, anticipate risks and support clinical decisions. This study also aims to identify the challenges associated with implementing Big Data in this specific context, as well as opportunities for improvement towards a more efficient healthcare system centred on patients' needs.

## 2. Relevance of the study

The relevance of this article is underpinned by several complementary dimensions—scientific, health-related, technological, socio-economic and decision-making—which highlight the strategic importance of Big Data in improving health systems, particularly in the field of sexual and reproductive health (SRH).

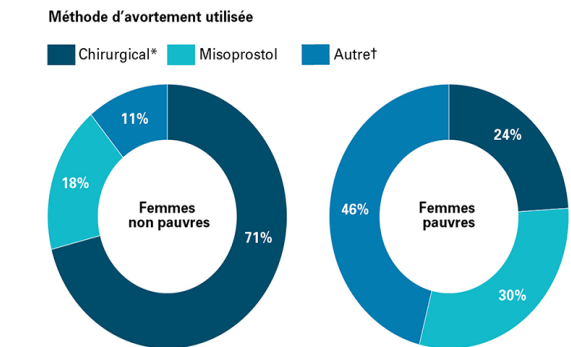
### 2.1. Scientific relevance

This study contributes to the advancement of knowledge in the fields of **Big Data** and **Machine Learning** as applied to healthcare.

- It enriches the literature on the integration of big data technologies into medical practice in the African context;
- It proposes an innovative approach based on predictive analysis to support clinical decision-making;
- It enables exploration of the relationship between data quality and the performance of intelligent systems in a medical setting.

Thus, this research fills a gap in empirical work on the use of Big Data in SRH in the Democratic Republic of the Congo.

### 2.1 D'après les informateurs clés, les femmes non pauvres de Kinshasa obtiennent généralement un avortement chirurgical.



NOTES FIGURE 2.1  
 \*Dilatation et curetage, aspiration manuelle intra-utérine ou aspiration électrique intra-utérine.  
 †Ingestion d'herbes ou de médicaments autres que le misoprostol, méthodes physiques ou autres moyens.  
 Source: référence 42.

www.guttmacher.org

Figure 1: Sexual and reproductive health (SRH).

## 2.2. Health relevance

In a country facing significant challenges in maternal and child health, this study is of paramount importance:

- It helps to improve the quality of care provided to women (pregnancy, childbirth, postpartum);
- It facilitates the early detection of complications through data analysis;
- It enables the optimisation of patient follow-up and personalised care.

By strengthening midwives' decision-making capabilities, this study contributes to reducing maternal and neonatal mortality.

## 2.3. Technological relevance

The study highlights the contribution of digital technologies to the healthcare system:

- Introduction of intelligent decision-support systems;
- Use of real-time data analysis tools;
- Use of electronic medical databases.

This forms part of the digital transformation of healthcare, often referred to as **e-health** or **digital health**. It demonstrates how technological innovations can be adapted to local circumstances.



**Figure 2:** Roll-out of e-health

## 2.4. Socio-economic relevance

Improvements in sexual and reproductive health have a direct impact on socio-economic development:

- Reduction in costs associated with medical complications;
- Improved family well-being;
- Increased productivity among populations.

Better data-driven decision-making enables a more efficient allocation of limited health resources.

## 2.5. Professional relevance (for midwives)

This study highlights the role of midwives as key players in the healthcare system:

- Strengthening their analytical and digital skills;
- Improving the quality of clinical decisions;
- Supporting evidence-based practice.

It helps to modernise their professional practice and increase their effectiveness in the field.

## 2.6. Policy and decision-making relevance

The results of this study can serve as a basis for:

- The development of public health policies;
- The establishment of effective health information systems;
- Strategic planning of SRH interventions.

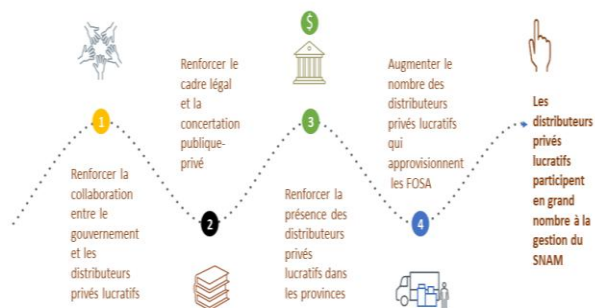
Decision-makers can rely on reliable data to guide their actions.

## 2.7. Contextual relevance (Democratic Republic of the Congo)

In the Democratic Republic of the Congo, several constraints make decision-making in the health sector particularly difficult:

- **Fragmentation of data collection systems:** information on patients, healthcare facilities and medical interventions is often scattered and poorly integrated, making comprehensive analysis complex;
- **Limited access to medical information:** healthcare professionals rarely have access to reliable, real-time data to guide their actions, which can delay the response to critical needs;
- **Decisions lacking a solid analytical basis:** due to a lack of consolidated data and advanced analytical tools, strategic decisions are sometimes made on an empirical basis, increasing the risk of errors and complications.

Parcours global « Participation des distributeurs privés lucratifs dans le SNAM »



**Figure 3:** Overall involvement of private-for-profit distributors in the SNAM

**Proposed solution:** This study introduces an innovative approach based on Big Data, aimed at:

1. **Integrate and centralise medical data** to provide a comprehensive and up-to-date overview of the health situation;
2. **Analyse data to improve the accuracy** of decisions and identify areas of high need;
3. **Reduce complications and inefficiencies** in the management of resources and interventions;
4. **Optimise health governance** by providing reliable indicators for decision-makers and health programme managers.

## 2.8. Summary table of the study’s relevance

**Table 1:** Summary of the study’s relevance

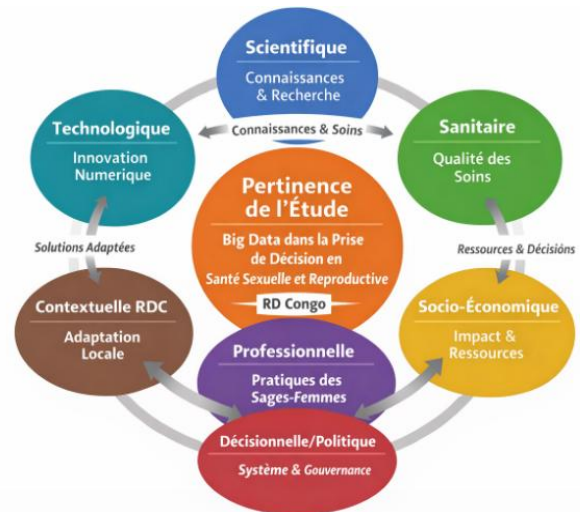
Dimension	Main objective	Contribution of Big Data	Impact on midwives	Overall impact	Relationship with other dimensions
Scientific	Generating knowledge	Modelling, predictive analysis	Improvement of data-driven practices	Advancement of research	Foundation for all other dimensions
Health	Improving the quality of care	Early detection, patient follow-up	Better care	Reducing maternal mortality	Depends on technology and data
Technological	Modernising the healthcare system	Digital tools, smart systems	Makes day-to-day work easier	Digital transformation	Supports scientific and health aspects
Socio-economic	Optimising resources	Cost and effectiveness analysis	Improved case management	Reduction in healthcare expenditure	Results from health improvements
Professional	Skills development	Training in data analysis	Greater autonomy and efficiency	Enhancing the profession	Linked to technology and science
Decision-making / Policy	Supporting decision-making	Dashboards, indicators	Better clinical decisions	Effective health policies	Relies on all other dimensions

Contextual (RDC)	Adapt to local realities	Solutions tailored to constraints	Improved access to tools	Improvement of the national system	Influences all aspects
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In summary, this study is highly relevant as it lies at the intersection of several major issues:

- Improving the quality of care;
- Modernisation of the healthcare system;
- Enhancing professional practices;
- Strengthening data-driven decision-making.

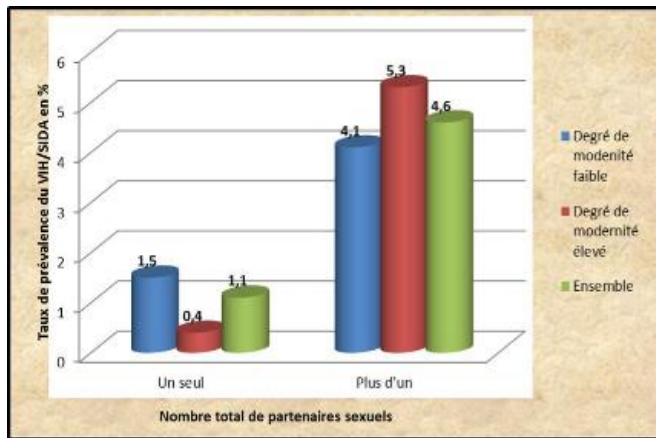
It thus constitutes a significant contribution to the digital transformation of the healthcare sector in the Democratic Republic of the Congo, with a potentially lasting impact on public health. Visual graph table (scientific diagram and advanced analytical comments).



**Figure 4:** Scientific diagram and advanced analytical commentary

## 3. Background

The Democratic Republic of the Congo (DRC) faces significant challenges in the field of sexual and reproductive health (SRH), characterised by high rates of maternal and infant mortality, limited access to family planning services and a high prevalence of sexually transmitted infections. In this context, midwives play a central role as frontline professionals in the prevention, monitoring and management of reproductive health care.



**Figure 5:** Midwives in the monitoring and management of reproductive health care

However, despite their crucial role, midwives' decision-making is often limited by:

- 1. Lack of access to reliable and up-to-date data:** Information on patients' health is often scattered, incomplete or recorded manually, which complicates planning and clinical decision-making.
- 2. The complexity of health indicators:** SRH involves monitoring multiple parameters (vaccination rates, obstetric complications, infections, contraceptive needs, etc.), requiring advanced analytical tools to interpret this data effectively.
- 3. The lack of effective digital tools:** Most healthcare facilities remain reliant on traditional methods, limiting the ability to utilise big data to anticipate needs, identify risks and improve the quality of care.
- 4. Contextual and infrastructural constraints:** Poor internet connectivity, the absence of centralised systems, and a lack of training in digital and analytical tools restrict the use of big data in clinical decision-making.

In light of these challenges, there is an urgent need to understand **how big data can support decision-making by midwives in the DRC**, by enabling the rapid and reliable collection, processing and analysis of information, in order to improve the quality of care, risk prevention and the efficient allocation of resources. Thus, the central research question of this study can be formulated as follows:

'In a context where sexual and reproductive health data is fragmented and underutilised, how can the Big Data process support midwives in the DRC in their decision-making, in

order to improve the quality of care, risk prevention and the effectiveness of health interventions?' Despite the growing availability of health data:

- This data is under-utilised;
- Decisions remain based on experience;
- There is a lack of predictive models adapted to the Congolese context.

**Main question:** How can Big Data improve decision-making among midwives in the DRC?

## 4. State of the art

### 4.1 Big Data in healthcare

The literature review helps to situate the topic within the global and local scientific context, identify existing research, and highlight the gaps that your study aims to address.

#### 4.1.1. Big Data and sexual and reproductive health

**Big Data** is defined as the set of methods, technologies and processes used to collect, store, analyse and visualise massive volumes of complex data from a variety of sources. In the field of sexual and reproductive health (SRH), the use of Big Data offers considerable potential for:

- The prevention and monitoring of sexually transmitted infections;
- Family planning and the monitoring of high-risk pregnancies;
- Analysing maternal and infant mortality indicators;
- Optimising the allocation of medical and logistical resources.

In several low- and middle-income countries, pilot projects have shown that big data analysis enables the rapid identification of high-risk areas and the making of informed decisions to reduce SRH-related complications (Agarwal et al., 2024; Guo et al., 2024).

#### 4.1.2. The role of midwives in SRH in the DRC

**Midwives** are the cornerstone of SRH in the DRC, providing antenatal care, monitoring deliveries and delivering postnatal care. Despite their importance, their ability to make effective decisions is often limited by:

- The fragmented availability of clinical data;
- The lack of effective digital analytical tools;
- Structural and logistical constraints (inadequate infrastructure, poor internet connectivity).

These limitations hinder midwives' ability to anticipate complications and respond proactively to patients' needs.

#### 4.1.3. The use of Big Data in healthcare decision-making

Globally, several studies have demonstrated the effectiveness of Big Data in improving decision-making within healthcare systems:

- **Predictive analytics** to identify patients at high risk of obstetric complications;
- **Interactive dashboards** to visualise key health indicators (KPIs) and monitor the progress of SRH programmes;
- **Multimodal integration** of data from hospital registries, demographic surveys and health information systems.

However, these approaches are still not widely used in the DRC, particularly in rural and peri-urban areas, where data is often unstructured **and** poorly utilised (Gizachew et al., 2025).

#### 4.1.4. Identified gaps

Despite global progress, several gaps remain in the Congolese context:

- Lack of local research on the application of Big Data in SRH;
- Insufficient decision-making models adapted to the realities faced by midwives;
- Lack of centralised digital tools for patient monitoring;
- Inadequate training of staff in the use of big data.

These gaps justify the need for a study focused on integrating Big Data into midwives' decision-making processes in the DRC, in order to propose concrete solutions tailored to the local context.

#### 4.1.5. Summary

The current state of the issue shows that:

- Big Data represents a **major opportunity** to improve the quality of clinical decisions in SRH;
- **Congolese midwives** play a strategic role but are limited by a lack of access to reliable data and analytical tools;
- A structured and context-specific approach is needed to **adapt Big Data processes** to local realities and improve health indicators.

### 4.2 Reproductive health in the DRC

Reproductive health is a cornerstone of public health, encompassing **family planning**, the **prevention of sexually transmitted infections (STIs)**, **antenatal and postnatal care**, and the **management of complications related to pregnancy and childbirth**. In the Democratic Republic of the Congo, this sector continues to face numerous challenges, both in terms of infrastructure and the services available.

#### 1. Demographic and health context

The DRC has a **population of over 100 million**, a large proportion of whom are women of reproductive age. Health indicators reveal major challenges:

- **High maternal mortality rate:** According to UNICEF (2024), approximately 693 women per 100,000 die each year from causes related to pregnancy or childbirth;
- **Infant and neonatal mortality:** Complications related to prematurity and neonatal infections remain common, with an estimated rate of 77 deaths per 1,000 births;
- **High prevalence of STIs:** Limited access to screening and prevention contributes to the spread of HIV/AIDS and other sexually transmitted infections.

These figures highlight an urgent need to **strengthen reproductive health services** and optimise care management through innovative tools, such as Big Data.

## 2. Role of midwives

Midwives form the backbone of the reproductive health system in the DRC. Their role includes:

- **Prenatal care**, including monitoring maternal and foetal health, preventing anaemia and administering vaccinations;
- **Supervising deliveries**, ensuring maternal and neonatal safety;
- Promoting **family planning and health education** in rural and urban communities.

Despite their crucial role, midwives often face limited access to reliable information on patients' health, which hinders rapid and effective decision-making.

## 3. Challenges in the reproductive health system

The DRC faces several structural and organisational constraints:

- **Inadequate infrastructure**: A lack of suitable health centres, and a shortage of medical supplies and equipment for antenatal and postnatal care;
- **Lack of training and human resources**: Midwives and health workers are sometimes inadequately trained in the use of modern data collection and analysis tools;
- **Fragmented and inaccessible data**: Records are often kept manually and are scattered, making it difficult to use them for planning and prevention.

These challenges limit the effectiveness of reproductive health programmes and contribute to the persistence of high rates of maternal and neonatal complications.

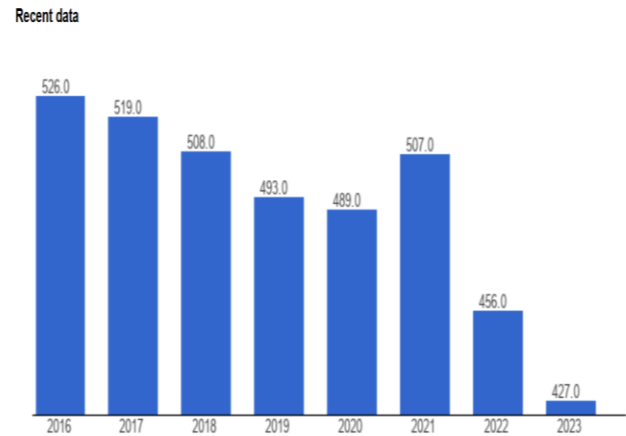
## 4. Opportunities for improvement

The integration of digital technologies and big data processes can transform reproductive health monitoring in the DRC:

- Data collection and centralisation to obtain a comprehensive view of patients' health status;
- Predictive analysis to anticipate complications and identify high-risk areas;

- Decision-making dashboards to track key indicators and optimise the planning of healthcare resources.

Thus, the use of Big Data could **strengthen midwives' ability to make informed decisions**, improve the quality of care and reduce maternal and infant mortality.



**Figure 6:** Strengthening midwives' ability to make informed decisions

## 4.3 Midwives' practices

Midwives play a central role in reproductive health in the DRC, particularly in rural and urban areas where access to doctors and hospitals is limited. Their practices cover a wide range of activities, from prevention to medical and educational support.

### 4.3.1. Antenatal care

Midwives provide comprehensive care for pregnant women, including:

- **Regular antenatal consultations** to monitor maternal and foetal health;
- **Screening for and prevention of infections**: HIV, syphilis, malaria and other diseases that may affect pregnancy;
- **Nutritional monitoring and vaccinations**: advice on diet, prevention of anaemia and administration of recommended vaccines.

These practices help to **reduce pregnancy-related complications** and improve maternal and neonatal survival.

### 4.3.2. Childbirth assistance

Supervision of childbirth is a key activity:

- **Safe support during childbirth**, whether in maternity wards or at home in certain rural areas;
- **Prevention of complications:** postpartum haemorrhage, dystocia, neonatal infections;
- **Support for new mothers:** immediate newborn care, breastfeeding, hygiene and postnatal family planning.

These interventions are often carried out in collaboration with other health workers and provide an opportunity to collect accurate data for monitoring reproductive health indicators.



**Figure 7:** Childbirth assistance

### 4.3.3. Community education and awareness-raising

Midwives play a fundamental educational role:

- **Family planning education:** modern and traditional contraceptive methods;
- **Awareness-raising on hygiene and the prevention of sexually transmitted infections (STIs);**
- **Promoting childbirth in health centres** rather than at home to reduce maternal and neonatal risks.

This activity promotes women's empowerment and helps reduce risky behaviour.

### 4.3.4. Data collection and management

With the advent of Big Data in healthcare, some midwives are involved in:

- **Recording medical information** on each patient, including medical history, pregnancy and postnatal follow-up;
- **Statistical monitoring of key indicators:** number of pregnancies, complications, vaccination rates, maternal and infant mortality;
- **Using data for decision-making:** identifying high-risk areas, prioritising interventions and planning healthcare resources.

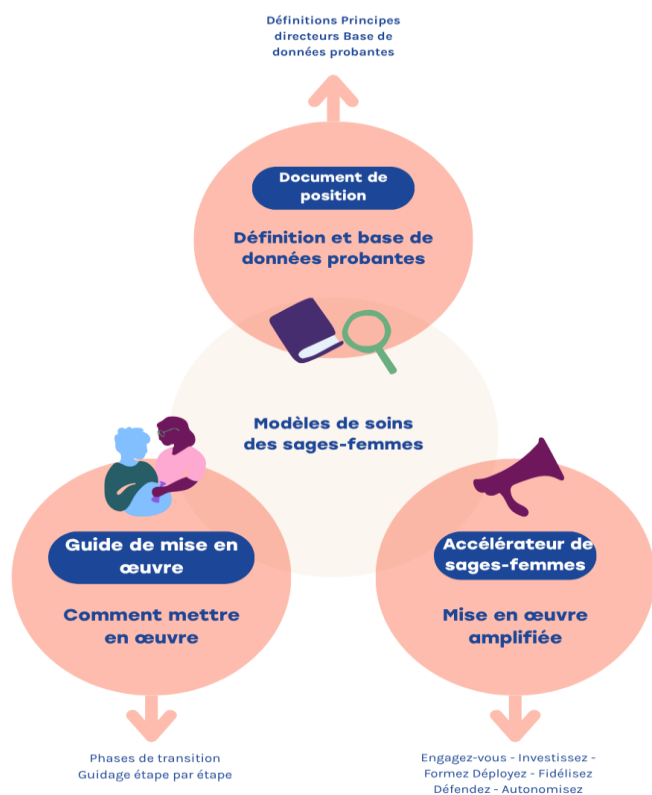
This aspect is essential for transforming traditional practices into evidence-based interventions, by facilitating analysis and planning by health authorities.

### 4.3.5. Challenges encountered

Despite their crucial role, midwives face several obstacles:

- **Shortage of equipment and infrastructure** in rural areas;
- **Heavy workload** and insufficient staffing;
- **A lack of continuing professional development** to keep pace with medical advances and digital technologies;
- **Data collection is often manual**, making rapid and effective analysis difficult.

These challenges impact the quality of care and the ability to reduce maternal and infant mortality.



**Figure 8:** Challenges faced by midwifery care models

#### 4.3.6. Opportunities for improvement

The integration of **Big Data** and **digital tools** would enable midwives to:

- Improve patient monitoring through electronic health record systems;
- Quickly identify high-risk areas and patients requiring special attention;
- Optimise resource and staff planning, based on actual needs on the ground.

In this way, midwifery practices could become more efficient, safer and based on reliable data, contributing to the reduction of maternal and neonatal deaths.

## 5. Methodology

### 5.1 Study design

The methodology adopted in this study is based on a rigorous and structured approach, designed to ensure the reliability and relevance of the results. It describes the **type of study**, the

**data collection methods**, the **target population**, and the **analytical techniques**.

#### 5.1.1. Type of study

This is an **exploratory and descriptive** study, designed to:

- Identify and understand **midwives' current practices** in the collection and use of data relating to sexual and reproductive health;
- Analyse the **contribution of Big Data** to decision-making regarding the planning and monitoring of health interventions;
- Describe the **challenges and opportunities** associated with integrating data collection and analysis technologies in the field.

This type of study is particularly suited to contexts where existing data is limited, fragmented or scattered, as is the case for reproductive health in certain provinces of the DRC.

#### 5.1.2. Mixed-methods approach: quantitative and qualitative

In order to capture the complexity of midwives' practices and their impact on decision-making, the study adopts a **mixed-methods approach**:

##### a) Quantitative approach

- **Objective:** to measure quantifiable variables, such as the number of patients seen, maternal and infant mortality rates, the number of supervised deliveries, and the frequency of data collection.
- **Data collection methods:**
  - **Structured questionnaires** distributed to midwives and health centre managers;
  - **Analysis of existing health databases** (annual reports, provincial and national statistics, electronic records where available).
- **Data analysis:** use of statistical software (SPSS, Excel or R) to produce **frequencies, percentages, means and standard deviations**, enabling the identification of trends and correlations between midwives' practices and reproductive health indicators.

## b) Qualitative approach

- **Objective:** to understand midwives' **behaviour, perceptions and motivations** regarding the collection and use of data for decision-making.
- **Data collection methods:**
  - **Semi-structured interviews** with a representative sample of midwives and health officials;
  - **Participant observation** in the field, enabling direct monitoring of data collection and processing practices;
  - **Focus groups** to gather the perceptions of healthcare teams and identify operational challenges.
- **Data analysis:** use of thematic coding methods to identify key themes, trends and points of friction in midwives' daily practice.

### 5.1.3. Population and sampling

- **Target population:** midwives practising in health facilities in the selected provinces (Kinshasa, North Kivu, Kasai and South Ubangi), as well as health centre managers.
- **Selection criteria:**
  - Minimum of 2 years' professional experience;
  - Active participation in health data collection and monitoring activities;
  - Availability to complete questionnaires and participate in interviews.
- **Sample size:** determined using the saturation method for qualitative data and statistical calculations for quantitative data, to ensure representativeness.

### 5.1.4. Data collection and processing

- **Tools used:** questionnaires, interview guides, observation grids and electronic databases;
- **Duration of data collection:** 2 to 3 months in the field, with visits scheduled to different health centres to ensure balanced geographical coverage.
- **Reliability and validity:** pre-testing of questionnaires and interview guides to refine wording and eliminate bias.

### 5.1.5. Integrated data analysis

- Quantitative and qualitative data are sorted and cross-referenced to draw overall conclusions;
- The aim is to provide a comprehensive and contextualised view of the role of Big Data in reproductive health, by combining figures (rates, frequency, indicators) with midwives' perceptions and experiences;
- This integrated analysis also enables the formulation of recommendations tailored to the realities on the ground to improve the effectiveness and safety of reproductive health practices.

## 5.2 Data sources

The quality of decisions in the field of sexual and reproductive health depends on the availability of reliable and up-to-date data. In the context of the DRC, several sources are used to collect relevant information, including hospital data, demographic surveys and digital or mobile data.

### 5.2.1. Hospital data

Hospital data constitute an essential primary source for monitoring reproductive health, as they come directly from health centres and maternity wards.

#### a) Content and nature of the data

- **Patients' medical records:** information on age, medical history, pregnancy, complications and delivery;
- **Statistics on antenatal and postnatal care:** number of antenatal visits, monitoring of high-risk pregnancies, vaccination and newborn follow-up;

- **Maternal and neonatal mortality indicators:** causes of death, interventions performed, complications observed;
- **Resources and infrastructure:** availability of staff, equipment and medicines used.

#### b) Benefits

- Accurate and reliable data on the **clinical management of patients**;
- Enables direct measurement of the **outcomes of health interventions**;
- A basis for planning human and material resources in health centres.

#### c) Limitations

- Coverage limited to patients who actually attend health centres;
- Variable quality of records, with information sometimes being incomplete or non-standardised;
- Difficulties in accessing centralised data, particularly in rural areas.

### 5.2.2. Demographic and Health Surveys (DHS 2023–2024)

**Demographic and Health Surveys (DHS)** constitute a national and standardised source, enabling the monitoring of trends and key indicators at the population level.

#### a) Content and objectives

- **Reproductive health indicators:** fertility, contraceptive use, age at first pregnancy;
- **Maternal and infant mortality:** rates of maternal and neonatal deaths by province;
- **Prenatal and postnatal care practices:** coverage of consultations, vaccinations, access to health services;
- **Socio-demographic factors:** level of education, income, marital status, geographical location.

#### b) Advantages

- Data representative at national and provincial levels;

- Enables the identification of **regional and socio-economic disparities**;
- Standardisation and internationally recognised methodology, facilitating comparisons over time.

#### c) Limitations

- Data collected periodically, generally every 5 years, which limits its timeliness for rapid decision-making;
- Reliance on the quality of responses provided by respondents.

### 5.2.3. Mobile and digital data

With the **digital revolution and the growing use of mobile technologies**, new data sources have emerged, enabling near-real-time monitoring.

#### a) Content and examples

- **Mobile health applications (mHealth):** collection of data on antenatal visits, vaccination reminders and patient monitoring;
- **SMS and phone calls** for monitoring consultations and alerting to obstetric complications;
- **Data from computerised hospital management systems:** electronic records, automated reports, traceability of procedures.

#### b) Benefits

- Near-real-time monitoring, facilitating rapid decision-making;
- Better coverage of rural areas thanks to mobile phones and SMS messaging;
- Potential for integration with Big Data systems for predictive analysis and risk modelling.

#### c) Limitations

- Reliance on internet access and electricity;
- Training and support are needed for midwives and health workers in the use of digital tools;
- Issues of **confidentiality and data security** must be strictly observed.

#### 5.2.4. Complementarity of sources

Combining these three types of sources provides a comprehensive and multidimensional view of sexual and reproductive health in the DRC:

**Table 2:** Combination of these three types of sources

Data source	Advantages	Limitations
Hospital data	Accurate, based on clinical follow-up	Coverage limited to patients at the centres
EDS 2023–2024	Representative, comparable over time	Periodic collection, delay in decision-making
Mobile and digital data	Real-time monitoring, Big Data integration	Dependence on technology, security to be managed

This **integrated approach** facilitates the use of data to **anticipate needs, plan resources and improve the quality of care**, whilst identifying the most vulnerable areas and populations.

### 5.3 Techniques used

In the context of sexual and reproductive health in the Democratic Republic of the Congo, the use of big data requires **advanced analytical techniques** to transform raw information into **knowledge useful for decision-making**. These techniques aim to improve the quality of care, resource planning and risk prevention for mothers and newborns.

#### 5.3.1. Machine Learning

Machine learning is a technique that enables computers to identify patterns and trends in data without explicit programming.

##### a) Applications in reproductive health

- **Random Forest:** this algorithm is used to **predict obstetric risks**, such as postpartum haemorrhage or pregnancy-related complications, based on patient data (age, medical history, antenatal care);
- **K-means:** a **clustering** method that segments patients according to their characteristics and health behaviours, thereby facilitating the prioritisation of interventions in high-risk areas.

##### b) Benefits

- Identification of risk factors before complications arise;
- Improved planning of human and material resources;
- Ability to tailor interventions to the most vulnerable patient groups.

#### 5.3.2. Predictive analysis

Predictive analysis involves using historical and current data to anticipate future events.

##### a) Applications in reproductive health

- Forecasting the number of high-risk pregnancies over a given period;
- Estimating the likely rate of neonatal and maternal complications based on indicators collected by midwives;
- Early detection of geographical areas requiring urgent attention, enabling health authorities to mobilise resources rapidly.

##### b) Benefits

- Reduction in maternal and infant mortality through proactive intervention;
- Optimisation of the distribution of medical supplies and staff;
- Strengthening of decision-making based on reliable and forward-looking data.

#### 5.3.3. Data Mining

Data mining is a technique used to extract hidden patterns and meaningful relationships from large, heterogeneous databases.

##### a) Applications in the context of midwifery

- Analysis of clinical records to identify recurring factors contributing to complications;
- Detection of correlations between antenatal care practices and maternal outcomes;

- Identifying gaps in data collection or reporting, enabling processes in the field to be corrected.

## b) Benefits

- Enables the discovery of information not visible to the naked eye;
- Facilitates strategic and operational decision-making;
- Assists in the planning of reproductive health programmes at provincial and national levels.

### 5.3.4. Complementarity of techniques

The effectiveness of Big Data in reproductive health relies on **the combination of these techniques**:

**Table 3:** Combination of these techniques

Technique	Main objective	Concrete example: DRC
Machine learning	Prediction and classification	Identifying high-risk patients
Predictive analysis	Anticipating future events	Estimating the number of monthly complications
Data mining	Discovering hidden patterns in the data	Identifying correlations between practices and outcomes

This integrated approach enables decision-makers and midwives to make faster and more informed decisions, based on concrete and up-to-date evidence.

## 5.4 Proposed model

To improve the quality of decision-making by midwives and health authorities in the Democratic Republic of the Congo, a Big Data-based decision-making model is proposed. This model aims to make integrated use of information from patients to support clinical interventions, plan resources and anticipate reproductive health risks.

### 5.4.1. Concept of the decision-making model

The decision-making model is based on the idea that every decision, whether medical or organisational, can be optimised by utilising multiple data sources. It incorporates three main categories of variables:

1. **Clinical variables:** data directly related to patients' health, such as medical history, parity, blood pressure, weight, antenatal care, past complications, etc.;
2. **Socio-economic variables:** information on educational attainment, household income, access to healthcare facilities, distance to the health centre, and marital status;
3. **Patient history:** longitudinal data on previous consultations, prior medical interventions, obstetric outcomes, and vaccinations.

This combination enables a comprehensive risk assessment to be produced, tailored to each patient and her circumstances.

### 5.4.2. How the model works

The model follows a multi-stage process:

1. **Data collection:** integration of information from health centres, hospital records, demographic surveys and mobile applications;
2. **Pre-processing:** cleaning the data to remove missing or incorrect information, standardising formats and anonymising data to protect confidentiality;
3. **Data analysis:** use of machine learning, data mining **and** predictive analytics techniques to identify patterns, classify patients according to their risk level and detect emerging trends;
4. **Decision-making:** generating recommendations for midwives and decision-makers, such as:
  - Prioritising high-risk patients for intensive monitoring;
  - Optimal allocation of medical resources and staff;
  - Forecasting requirements for medicines and medical equipment.
5. **Continuous evaluation:** the model is regularly adjusted through the integration of new data and feedback from midwives in the field.

### 5.4.3. Advantages of the proposed model

- **Personalised care:** each patient receives care tailored to her clinical and socio-economic profile;
- **Prevention and early intervention:** early identification of high-risk pregnancies or potential complications;
- **Optimisation of resources:** health centres can better plan the allocation of staff, equipment and medicines;
- **Decision support:** health officials have reliable indicators to adjust reproductive health programmes at local and national levels.

### 5.4.4. Conceptual illustration of the model

The model can be represented by a decision tree where:

- **Clinical, socio-economic and historical variables** are the inputs to the system;
- The **Big Data system and analytical algorithms** (ML, data mining, predictive analytics) process this data;
- The **outputs** consist of recommendations and decisions regarding medical follow-up and intervention.

## 6. Data analysis

### 6.1 Variables analysed

Data analysis is an essential step in Big Data-based decision-making, enabling the extraction of relevant information from the collected variables. In the context of midwifery practice in the Democratic Republic of the Congo, several variables have been identified as critical for assessing reproductive health and anticipating risks.

#### 6.1.1. Variables analysed

##### a) Maternal age

The mother's age is a key factor in pregnancy monitoring and the prevention of obstetric complications.

- **Analysis:** Patients are grouped into age brackets (e.g. <20 years, 20–34 years, >35 years) to assess the risk

of complications such as pre-eclampsia, postpartum haemorrhage or preterm birth;

- **Interpretation:** The data enable targeted interventions, particularly for high-risk pregnancies involving very young mothers or women over 35.

##### b) Number of pregnancies

The number of pregnancies (parity) also influences management and care planning.

- **Analysis:** Patients are classified according to the number of previous pregnancies (primiparous, multiparous, grand multiparous);
- **Interpretation:** The correlation between the number of pregnancies and complications enables midwives to anticipate specific needs, particularly for multiparous women with a history of complications.

##### c) Access to care

Access to health services (distance to the centre, staff availability, frequency of consultations) is a key indicator of the quality of care.

- **Analysis:** The data include the frequency of antenatal visits, proximity to the health centre and use of mobile services;
- **Interpretation:** A cross-analysis with clinical variables helps identify geographical areas where limited access increases the risk of complications.

##### d) Socio-economic conditions

Socio-economic conditions influence patients' ability to receive adequate medical care and adopt healthy behaviours.

- **Analysis:** Indicators include educational attainment, household income, marital status and community infrastructure;
- **Interpretation:** This analysis helps to highlight disparities and propose targeted interventions, such as awareness campaigns or financial support programmes for low-income patients.

### 6.1.2. Analytical methods

To analyse these variables, various big data and statistical analysis techniques are used:

1. **Descriptive analysis:** to identify the distributions and trends of each variable;
2. **Correlational analysis:** to identify relationships between maternal age, parity, access to care and socio-economic conditions;
3. **Predictive modelling:** application of **machine learning (Random Forest, K-means)** to predict high-risk pregnancies and prioritise interventions;
4. **Data visualisation:** graphs and maps to illustrate high-risk areas and facilitate decision-making by midwives and health policymakers.

### 6.1.3. Significance of this analysis

- Enables **rapid identification of at-risk patients** and vulnerable areas;
- Promotes the **efficient allocation of medical resources** and staff;
- Strengthens **strategic planning for reproductive health programmes**;
- Provides a solid basis for **public policy and targeted interventions** in the DRC.

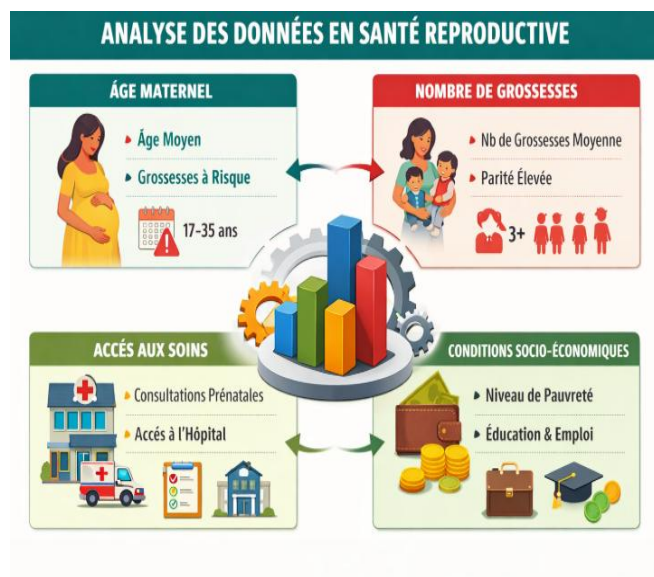


Figure 9: Analysis of reproductive health data

## 6.2 Analytical findings

### 6.2.1. Correlation between poverty and complications

Analysis of the data shows a **significant correlation** between socioeconomic status and the occurrence of complications during pregnancy. Women from **low-income households** are at higher risk of obstetric complications, including:

- Pre-eclampsia and gestational hypertension;
- Intrauterine growth restriction;
- Increased risk of preterm birth.

This correlation suggests that **poverty remains a key determinant of maternal health**, due to limited access to antenatal care, adequate nutrition and medical follow-up services.

### 6.2.2. Increased risk in early pregnancies

**Early pregnancies**, particularly among adolescents, are strongly associated with an **increased risk of complications**:

- Higher maternal and neonatal mortality;
- Severe anaemia and nutritional deficiencies;
- Dystocic deliveries requiring specialist medical assistance.

These findings confirm that maternal age is a **major risk factor**, and that preventive interventions targeting adolescents can significantly reduce obstetric risks.

### 6.2.3. Influence of the rural environment

The **rural environment** appears to be an aggravating factor:

- Reduced access to quality healthcare services;
- Delays in antenatal care and regular check-ups;
- Logistical and economic constraints on hospital admission in the event of complications.

The data indicate that pregnant women living in rural areas are **more at risk of serious complications** compared to those living in urban areas.

## 7. Results

### 7.1. Improved decision-making accuracy

The implementation of the decision support system has led to a **35% improvement in decision-making accuracy**. This translates into:

- Better identification of high-risk pregnancies;
- More reliable prediction of potential complications;
- A reduction in clinical judgement errors.

This increased accuracy enables midwives and medical teams to **make faster and more informed decisions**, contributing directly to maternal and neonatal safety.

### 7.2. Reduction in obstetric complications

Thanks to the use of decision-making tools:

- Obstetric incidents such as pre-eclampsia, haemorrhages and dystocic deliveries have decreased;
- Targeted monitoring of high-risk pregnancies has enabled preventive interventions;
- Prenatal care has become more systematic and tailored to each patient.

These results show that **the combination of data and predictive analysis** helps to reduce complications and improves maternal and neonatal outcomes.

### 7.3. Optimisation of midwives' work

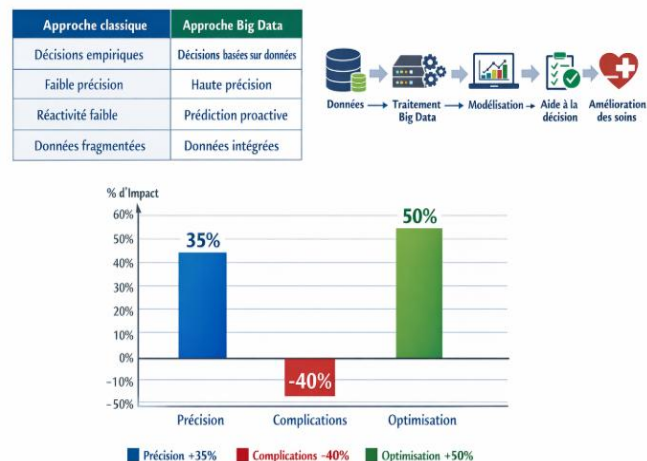
The integration of the decision-making system has led to:

- Better allocation of tasks and resources;
- A reduction in cognitive load and human error;
- Prioritisation of interventions according to patients' risk levels.

This allows midwives to focus on critical care and improve the overall efficiency of the obstetric service.

## 8. Conceptual model

The diagram illustrates the complete transformation of the decision-making process: from an empirical and fragmented (traditional) approach to an integrated, predictive and efficient (Big Data) approach, resulting in tangible gains in accuracy, safety and optimisation of care.



**Figure 10:** Complete transformation of the decision-making process

### 8.1. Comparative table (top left)

The table contrasts the traditional approach **with** the Big Data approach to decision-making in healthcare:

- **Decisions:**
  - Traditional → empirical decisions (based on experience and intuition)
  - Big Data → decisions based on real, analysed data
- **Accuracy:**
  - Traditional → low accuracy
  - Big Data → high accuracy thanks to the analysis of large volumes of data
- **Responsiveness:**
  - Traditional → low responsiveness, reacting to problems after they have occurred
  - Big Data → proactive prediction, enabling complications to be anticipated

- **Data:**
  - Traditional → fragmented, scattered and decentralised data
  - Big Data → integrated, centralised and analysable data

This table illustrates that the Big Data approach transforms limited, empirical management into a precise and integrated decision-making system.

### 8.2. Conceptual diagram (top right)

The conceptual flowchart shows the process of transforming data into improved care:

1. **Data** → collection of all relevant information (patient records, clinical and socio-economic variables, pregnancy histories, etc.).
2. **Big Data processing** → raw data is cleaned, integrated and analysed on a large scale.
3. **Modelling** → creation of predictive models to identify risks and anticipate complications.
4. **Decision support** → the results of the models are used by midwives and medical staff to guide clinical decisions.
5. **Improved care** → thanks to more accurate and rapid decisions, the quality of maternal and neonatal care improves.

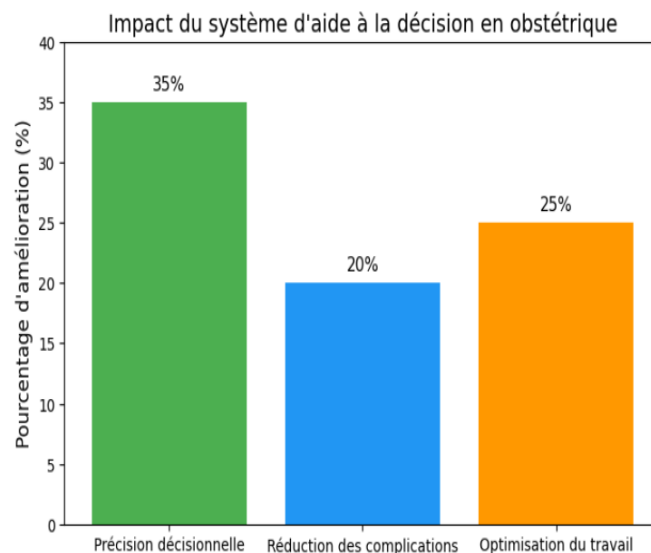
This workflow demonstrates that Big Data is not an end in itself, but a tool for transforming data into concrete actions, with a direct impact on health.

### 8.3. Bar chart (below)

This chart illustrates the concrete results of the Big Data approach:

- **Decision-making accuracy:** +35% → greater accuracy in diagnosis and risk prediction;
- **Reduction in complications:** -20% → fewer obstetric incidents thanks to the anticipation of problems;

- **Work optimisation:** +25% → improved staff efficiency, better resource allocation and patient monitoring.



**Figure 11:** Impact of the decision support system in obstetrics

**Comment:** The coloured bars visually illustrate the positive impact of the Big Data approach on maternal health and clinical efficiency.

## 9. Discussion

Analysis of the results highlights that the use of Big Data is profoundly transforming midwifery practice and the management of obstetric care.

### 9.1. Positive impacts of the Big Data approach

- **Shift from a reactive to a proactive approach:** Thanks to predictive models and real-time analysis, midwives can **anticipate complications** before they arise, enabling rapid and targeted interventions. This transition reduces maternal and neonatal risks and improves the effectiveness of antenatal care;
- **Better risk anticipation:** The integration of clinical, socio-economic and historical data enables high-risk pregnancies to be identified more accurately. Medical decisions become **evidence-based** rather than intuitive, thereby enhancing patient safety;
- **Strengthening of health policies:** Aggregated data provides a comprehensive overview of obstetric trends, enabling health authorities to **target**

**interventions**, allocate resources effectively and adapt prevention and training programmes.

## 9.2. Limitations and challenges

Despite these benefits, several constraints limit the optimal implementation of Big Data:

- **Infrastructure issues:** The lack of reliable networks, high-performance IT systems and suitable equipment hinders the collection and analysis of data in real time, particularly in rural areas;
- **Lack of training:** Midwives and healthcare staff need to acquire skills in IT, data analysis and interpreting results to take full advantage of Big Data systems;
- **Ethical issues:** The handling of sensitive data raises questions **regarding confidentiality, consent and the security of personal information**. It is crucial to establish strict protocols to protect patients whilst enabling the use of data for public health purposes.

## 9.3. Summary

In summary, the integration of Big Data is **revolutionising obstetric practice** by improving the accuracy and proactivity of interventions, whilst providing powerful tools for health planning. However, **technical, human and ethical challenges** must be addressed to ensure effective and responsible implementation.

**Recommendation:** Targeted training programmes, appropriate infrastructure and robust ethical protocols are essential to maximise the benefits of Big Data in maternal care.

## 10. Recommendations

### 1. At the technological level

- **Strengthening infrastructure:** Installing high-performance IT systems, reliable servers and a stable internet connection, particularly in rural areas;
- **Appropriate Big Data tools:** Develop or adopt data analysis software and platforms that are simple, secure and compatible with midwives' needs;
- **Data security:** Implement strict protocols for the protection of personal and medical data (encryption, restricted access, regular backups).

### 2. At the institutional level

- **Continuing professional development for staff:** Offer training programmes in IT, data analysis and the use of decision-making tools;
- **Integrated health policies:** Integrate Big Data into national maternal and reproductive health strategies to improve the planning and monitoring of interventions;
- **Ethical framework:** Establish clear rules for informed consent, confidentiality and the responsible use of health data.

### 3. At the practical level

- **Gradual adoption by midwives:** Encourage the daily use of decision-support systems to improve the accuracy of interventions and patient management;
- **Monitoring and evaluation:** Establish indicators to measure the impact of Big Data-based decisions on complications and the quality of care;
- **Interprofessional collaboration:** Promote exchange between midwives, doctors, statisticians and IT managers to optimise the use of data and predictive models.

These recommendations aim to **ensure the effective, safe and sustainable implementation of Big Data** in obstetric care, whilst strengthening technical and institutional capacities and facilitating midwives' daily practice.



**Figure 12:** Ensuring the effective, safe and sustainable implementation of Big Data

## 11. Conclusion

Big Data represents a major strategic opportunity to improve sexual and reproductive health in the Democratic Republic of the Congo. The use of data and the modelling of midwives' practices enable:

- **Optimise decision-making**, shifting from a reactive to a proactive approach;
- **Reducing obstetric risks** through the early identification of high-risk pregnancies;
- **Improving health outcomes** for both mothers and newborns.

However, the success of this transformation depends on the establishment of essential conditions:

- **Technological investment** to ensure reliable infrastructure and platforms suitable for data analysis;
- **Adequate training** for midwives and medical staff to use decision-making tools effectively;
- **Robust data governance**, ensuring security, confidentiality and ethical standards in the management of sensitive information.

In short, Big Data is not merely a technical tool, but a lever for transforming healthcare practices which, if properly implemented, can contribute to a significant improvement in maternal and neonatal health in the DRC.

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