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# INCOMPLETE CHRONICLES: UNVEILING DATA BIAS IN MATERNAL HEALTH

**Min'enhle Ncube**
Researcher & Applied Anthropologist

ARTIFICIAL INTELLIGENCE IN MATERNAL CARE IN ZAMBIA (AIMZ)

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# EXECUTIVE SUMMARY

Artificial intelligence (AI) has brought significant advancements in various domains, such as healthcare. However, the efficacy of these AI-driven technologies heavily depends on the quality and diversity of the data used to train them. In healthcare, where AI is increasingly leveraged for diagnostic and treatment purposes, the bias inherent in healthcare data sets can exacerbate existing health disparities, particularly in underrepresented regions such as Southern Africa (Zou & Schiebinger, 2021).

This report presents findings on how Dawa Health, a medical technology startup based in Lusaka, Zambia, has integrated AI into its maternal healthcare offerings and its DawaMom application. This ethnographic research examines the robustness and potential biases in the data sets and the technology behind the DawaMom app, including the influence that conventional categorisation and knowledge-storing approaches have on the dataset. Lastly, this research presents insights into how users interact with the DawaMom app, highlighting areas where the product's universalised design may only partially meet these expectant mothers' needs.

Due to the breadth of datasets used to train the DawaMom app, this research entailed conducting field site visits to cover a sample of archives across Southern Africa, including institutional archives, community and individual archives, and the Dawa Health data archive to understand and evaluate the efficacy of datasets used for training. It also considers the perspectives and approaches of Zambia's startup community and AI stakeholders, including ZICTA, an authority responsible for data and technology regulations.

This report's content and discussion emerge from the research emerging from Artificial Intelligence in Maternal Health in Zambia (AIMZ). This Mozilla Foundation-funded project spanned a five-month investigation of standardised and unstandardised data, the challenges and dangers posed by biased datasets in delivering quality and timely care to expectant mothers in Zambia, who are among the most vulnerable and impacted by AI-led decision-making.

*Image source: Dawa Health*

# INTRODUCTION AND BACKGROUND

Emerging technologies harnessing artificial intelligence (AI) to improve healthcare in Southern African communities promise to bridge health inequality gaps and improve livelihoods overall. However, ethnographic analysis of their engineering and approaches to data curated for automation indicates areas of bias that startups and other stakeholders of AI development should consider in their pursuit of developing automated healthcare technologies. One area concerns a narrow approach to what constitutes data incorporated into AI systems, and another regards the design of health apps lacking broader socio-economic perspectives in communities. These gaps are worth investigating when considering bias in AI systems and their usage.

Maternal health in Zambia provides ample enquiry on the effectiveness of emerging technologies and how startups are designing digital tools for expectant mothers across communities. Maternal health is a top priority for governments worldwide, but despite significant efforts, Sub-Saharan Africa still faces very high rates of maternal deaths. Reducing these deaths is a crucial goal of the Sustainable Development Goals (SDGs), specifically targets 3.1 and 3.8, which aim to cut the maternal mortality ratio to less than 70 deaths per 100,000 live births and achieve universal health coverage. Despite reducing maternal mortality, low-resource countries continue to struggle with this issue. Over the last 25 years, maternal deaths have decreased by about 44%, but this falls short of the Millennium Development Goal of a 75% reduction. In 2015, 99% of the 302,000 maternal deaths worldwide occurred in low-resource regions, with sub-Saharan Africa alone accounting for 66% of these deaths, totalling 201,000 fatalities.

The scope of emerging technology intervention in Sub-Saharan Africa predominantly harnesses the use of mobile phone technology to deliver messaging or services for expectant mothers. For instance, automated voice calls and text messages have delivered critical health information and reminders to expectant mothers, helping to educate and empower mothers in managing their health and that of their children (ARMMAN, 2024). Through bridging the gap in healthcare access, especially in rural areas, telemedicine also uses AI to triage patients and provide teleconsultations, which include maternal health services (Babyl, 2024). Other mobile-powered apps have used AI-driven systems to tailor maternal health information through SMS and WhatsApp messages to the user's stage of pregnancy or the age of their baby, ensuring relevant and timely advice. This report shines a light, particularly on DawaMom, a product engineered by Dawa Health, a medical technology startup based in Lusaka, Zambia, whose features encompass AI to deliver timely and personalised feedback on one's gestation, supported by periodic home visits by the startup's clinician team. DawaMom's automated messaging is powered by generalised data combined with data collected from users by Dawa Health’s clinician team, such as their medical history, current health status, and demographic information, which is analysed to tailor and deliver personalised health information and recommendations through the app, ensuring that the advice is relevant to the individual's specific needs and circumstances. The metrics of this app rely on biomedical parameters despite other existing epistemologies of care that could be integrated, such as common herbal remedies. Overall, datasets grounded on the biomedical paradigm emphasise quantitative data, objective measurement, and clinical biomarkers, all of which value scientific and empirical evidence as the primary basis of understanding health and disease.

Conventional approaches to data or what qualifies as data have narrowly relied on perspectives from developed regions where digital and automated technologies have evolved significantly. Such approaches arguably stem from homogenised knowledge systems prioritising Western-centred pers-

pectives over those otherwise marginalised. In our era of automation and AI, fuelled by data, datasets, or curated repositories, this report illustrates the importance of investigating the normative approaches or decisions that qualify or disqualify data, particularly in regions whose development has been designed out of the context in which it is deployed (Escobar, 1997; Mosse, 2013). Reflecting on data collection practices from a Zambian startup, Dawa Health's design for an AI-driven tool to mitigate maternal health risks presents limitations of data qualified for their AI-driven solution and the usability of their app across different contexts. This project appreciates the effects of digitality that reduce human life to binary code (Miller and Horst, 2020). It aims to understand better the limitations of normative data incorporated into automotive or digital systems and analyse the implications of perspectives otherwise disqualified as health data.

Zambia has witnessed the emergence of a dynamic startup ecosystem that aims to tackle the multifaceted challenges in its postcolonial landscape. These innovative ventures, driven by a new generation of entrepreneurs, leverage technology, creativity, and a deep understanding of local needs to develop solutions potentially transforming the country's economic and social landscape. The rapid diffusion of digital technologies across Africa, as evidenced by the exponential growth in mobile phone adoption, mobile data usage, and the proliferation of entrepreneurial hubs, has paved the way for a startup movement in Zambia (Ndemo & Weiss, 2017). These technological advancements have unleashed many opportunities for technology-driven businesses to flourish, bridge inequality gaps and enable the country to transition from a resource-based economy to a rapidly industrial digital space across sectors such as healthcare.

This report highlights the opportunities and gaps in data that are fundamental to AI. It proves relevant for scholars and stakeholders of AI development whose objective is to understand the limitations posed by normative data (see Benjamin, 2019; Eubanks, 2018 and O'Neil, 2016) supporting AI or digital systems, the implications of valuable nuances otherwise disqualified as data, and the impact of deploying apps that account little for existing diversities across users.

Considering the challenge of having representative data for automotive AI healthcare, this project aimed to examine the extent and impact of data practices and their biases that have become inherent in AI-driven health technology in Zambia. The project dwelled on the extent to which startups perceive and approach data as they design AI-driven tools for healthcare. Furthermore, this offered the space to explore the inherent biases in historical healthcare archives, supporting the argument that historical biases on approaches to data for machine learning may persist in modern health AI applications, influencing effectiveness and fairness. The study analysed contemporary datasets and health records to uncover how historical biases may persist in modern AI applications, influencing their efficacy and fairness. This dual approach provides a comprehensive understanding of the continuity and impact of data bias over time, offering insights into how to mitigate such biases in future AI healthcare solutions.

This project hopes to inspire further research on areas of data on the African continent by suggesting that conventional archiving influences modern AI data biases in emerging technologies. These biases, embedded in historical healthcare records, have persisted and influenced contemporary AI models, shedding light on the continuity of data bias over time. Further insights point to data representativeness and fairness, which indicate the extent to which the AI application accurately represents the country's population, showing areas where data may be unrepresentative. The reflections shared during a workshop, *Box Breaking: Data, Dismantling and Developing*, that gathered Zambia's AI stakeholders in Lusaka provided valuable recommendations for developing ethical guidelines and policies to address and mitigate data biases in AI, ensuring that future healthcare technologies are more equitable and just.

# NAVIGATING THROUGH TIME AND SPACE

**Research Design**

The research involved conducting an archival ethnography on maternal health datasets and contemporary records, examining biases in data collection methods and biases in the DawaMom maternal health app. Additionally, collaborative efforts with technology startups and AI stakeholders in Zambia aimed to address biases in data regulation and promote culturally sensitive AI systems.

The ethnographic research investigated potential biases in maternal health datasets by examining health information and archival practices at institutions, sampling four institutional archives and a contemporary dataset from the DawaMom maternal health app. Hospital records were vital, and sourcing them from archived material was an essential alternative to conducting a hospital ethnography on similar records. While providing in-depth insights into healthcare practices, the latter method involved an ethical approval and access process that is notably extensive. These challenges include prolonged timelines for obtaining necessary permissions, ensuring compliance with strict ethical standards, and the significant financial costs associated with on-site data collection. Consequently, archival research provided a practical and viable approach, allowing for the comprehensive and wide examination of historical and institutional practices in maternal healthcare without the logistical and ethical complexities inherent in hospital ethnography of records.

This archival ethnography focussed on historical and contemporary records of maternal health practices, policies, and data collection methods across a century in Southern Africa (Zambia, Zimbabwe and South Africa) pre- and post-independence. This approach involved immersive engagement with the archives, exploring the socio-cultural and institutional contexts in which data were generated and recorded. This method critically examined how certain narratives and knowledge systems were privileged or marginalised over time. The component of in-depth analysis of DawaMom's maternal health app's dataset compared with archival insights to identify continuities and shifts in data collection biases, particularly those rooted in biomedical epistemologies. This comparative analysis revealed the assumptions and prejudices that shape maternal health data, offering insights into how historical legacies influence contemporary health practices and data governance.

Dawa Health has established partnerships to supplement its dataset repository, particularly with Delta Imaging, a Netherlands-based company specialising in medical imaging solutions. One of their products is the BabyChecker, designed to address maternal health needs in underserved areas. The BabyChecker has been implemented in Sub-Saharan countries like Zambia, Sierra Leone, and Kenya. It uses AI to analyse pregnancy ultrasound scans and provide vital information such as gestational age, foetal presentation, foetal heart rate, and placenta location. Through collaborations with clinics conducting these scans, the company gathers gestational data to drive AI-generated insights on maternal health.

The study concluded with collaborative storyboarding, gathering AI stakeholders in Zambia to address potential biases in startups and data regulation. The storyboarding session took place during a workshop in Lusaka titled *Box-Breaking: Data, Dismantling, and Development*, which was organised for startups and AI stakeholders in Zambia. The workshop provided valuable insights and discussions to help identify biases in data collection and usage practices, promoting more inclusive and culturally sensitive AI systems. Involvement by regulators and data managers was essential in discussing startup practices with national data governance frameworks and thinking about transparency, accountability, and ethical standards in AI technologies.

Overall, this research used archival ethnography at institutional archives and Dawa Health, with interviews conducted with respective interlocutors at these sites, medical professionals in Lusaka, mothers (some of whom have used Dawa Mom) and workshop storyboarding with Zambia's startup community and AI stakeholders. This opens space for further enquiry on how we might approach data when strategising for representative AI on the continent.

The methodological task of situating computational datasets within the conceptual framework of 'archives' involves critically examining how both data repositories are curated, reflecting similar subjectivities in their construction and interpretation (Jardine and Drage, 2018). Just as traditional archives are shaped by the decisions of archivists and guiding policies – regarding what is preserved, how it is categorised, and how it is contextualised – computational datasets are similarly influenced by the choices made by data scientists and engineers.

These choices include decisions about data collection methods, the selection of data sources, the processes for cleaning and preprocessing data, and designing algorithms that govern data analysis and interpretation. This parallel highlights the subjective nature of both archives and datasets, as both are products of human agency shaped by the cultural, institutional, and personal biases of those who curate them. Recognising this subjectivity is crucial in archival studies and data science, as it underscores the importance of transparency and reflexivity in creating and using these repositories and interpreting the knowledge they generate. Framing computational datasets as a digital archive, this research underscores the need for critical approaches that acknowledge and address the biases inherent in data curation and the implications for knowledge production and dissemination.

## Data Gathering

Examining inherent dataset biases in emerging health technology in Southern Africa by sampling institutional archives and analysing historical and current data collection practices, while also observing the DawaMom app's data and exploring the implications for knowledge production and dissemination.

The research examined inherent dataset bias in emerging health technology, focusing on traditional archiving in Southern Africa and the data repository of Dawa Mom, the maternal health app. The study sampled four institutional archives in the region: the National Archives of Zambia (Lusaka), the Zambia Consolidated Copper Mines (ZCCM) Archive in Ndola, the National Archives of South Africa (Pretoria), and the National Archives of Zimbabwe (Harare) to analyse historical and current data collection and healthcare delivery biases impacting maternal health in Southern Africa.

The National Archives of Zambia provided colonial and postcolonial government health letters, reports, medical records, public health campaign documents, Ministry of Health records, and administrative correspondences related to maternal health experiences. The ZCCM archives contained employee health program documents and documents on healthcare initiatives in the Copperbelt province. In South Africa, the research sourced apartheid-era and post-apartheid government healthcare reforms, reports on public health institutions, maternal health clinics, statistical data on maternal health, and public health campaign materials. Furthermore, the study gathered maternal and child health program files, guidelines, and health records from colonial and postcolonial periods in Zimbabwe.

The research also observed DawaMom's app data, which included user interaction logs, ongoing construction of Rudo (DawaMom's chatbot), and demographic information such as age, health symptoms, and biomarkers, aggregated and anonymised. The analysis focuses on how the app's content and advice align with or diverge from archival data and historical practices. Through a snowball approach, the research gleaned the perspectives of Dawa Health patients, some of whom had experience with the app and others without. These interlocutors also shared aspects of medical pluralism encompassing care in their maternal health experience, which opened space for interrogating the epistemic approach envisaged by developers versus other existing knowledge in communities.

Interrogating the data and what qualifies as part of a dataset allows exploring perspectives or elements otherwise disqualified from such repositories. Beyond the confines of a data archive are multiple nuances whose emission impacts the subjectivity of AI-trained models. Recent reflections of the archive point to its repository of incomplete or patchy documentation, hindering the broad understanding of the context in which they were created. Furthermore, colonial disciplinary assumptions underpin the building of datasets and archives, as their data collection

practices can obscure or misrepresent the histories of marginalised communities and trap materials into rigid categories. Open-source platforms (such as Kaggle) offer developers pools of datasets, but they also have metadata limitations, and their materials may not accurately reflect the complexities of broader contexts. A further critique of such metadata is worth exploring rather than passing it as authoritative towards 'refiguring the archive,' as aptly posited by Hamilton (2022), to refigure data collection practices that better accommodate diverse histories or perspectives.

The authority in question held by data repositories is rooted in the sacredness of coding, classifying and storing information that are performative rituals to honour memories - a quasi-religious performance akin to a temple, as Mbembe (2002) described. With this understanding, I explored through participant observation, interviewing and storyboarding other possible elements constituting a maternal health archive and the subjectivities that have disqualified them from inclusion.

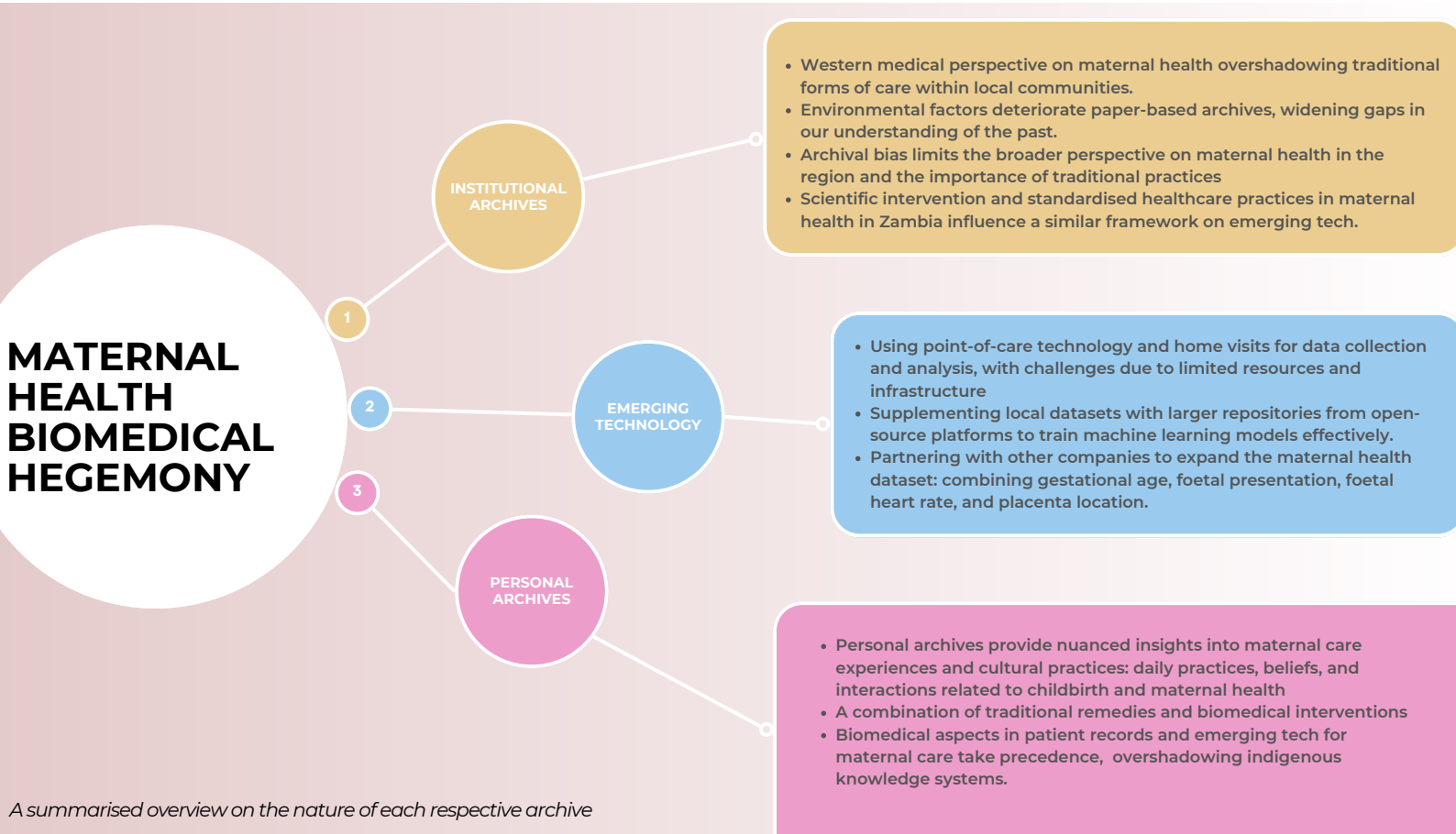
| | National Archives of Zambia | ZCCM Archives | National Archives of South Africa | National Archives of Zimbabwe | Dawa Health Data Repository |
|---|---|---|---|---|---|
| **Historical Period** | **1920s – 1970s** | **1950s – 1980s** | **1908 – 1960s** | **1890s – 1990s** | **2020 – present** |
| **Scope of Healthcare Information** | Investment into mining hospitals; negligence of childcare facilities; emergence of maternal and child health policy post-independence | Investment into mining hospitals; negligence of childcare facilities; emergence of maternal and child health policy post-independence | Racialised care institutions; urban/spatial planning; care segregations | Racialised care institutions; teaching hospitals/colleges; urban/city planning; care segregations | Maternal health metrics: blood pressure; haemoglobin levels; urinalysis; |
| **Type of documents** | Medical records, medical staff, inventory, administrative letters | Medical records, medical staff and services, medical procedures, inventory, educational materials, government reports, and health policy documents | Medical records, medical staff and services, inventory, educational materials, government reports, and health policy documents | Medical records, medical staff, educational materials, government reports, and health policy documents | Digital health records, Dawa Clerk sheets, Excel sheets; virtual dashboards |
| **Medical interventions** | Prenatal and postnatal care; biomedical practices | Prenatal and postnatal care; biomedical practices; specialist care | Prenatal and postnatal care; biomedical practices; specialist obsteretric care | Prenatal and postnatal care; biomedical practices; specialist care | Virtual assistance; referral to clinic/hospital; home visit by clinician for consultation |
| **Community and family interventions** | N/A | N/A | N/A | Midwifery in communities/at home between 1893 and 1904 | N/A |
| **Traditional medical records** | N/A | N/A | N/A | Zimbabwe National Traditional Healers' Association (ZINATHA) records | N/A |

# BIOMEDICAL HEGEMONY AND MATERNAL HEALTH ARCHIVES

**Research Outcomes** Biomedical knowledge is dominant across historical healthcare and maternal care archives, and traditional and Indigenous epistemologies need to be integrated. Digital archives and AI present challenges and opportunities in addressing historical incompleteness and biases in maternal health records.

The sampled archival sites visited offer a glimpse of biomedical knowledge's hegemony underpinning the historical understanding of healthcare and maternal care. Scholarship on the archives (such as Mbembe 2002; Hamilton and Cowling 2020) offers a place of departure, highlighting the incompleteness of these archives and the pressing need to recognise and integrate traditional and Indigenous epistemologies. My encounter with this biomedical underpinning of health in the archive also met the deterioration of physical documents that chronicle the continuity of memory. This physical decay of archival documents is not just a literal but also a metaphorical representation of the challenges in maintaining a comprehensive historical narrative. In these repositories lie the biases and priorities of maternal health history that favour certain narratives over others. As a result, this documented memory fails to fully encompass the holistic experiences of maternal care providers and recipients, especially from marginalised communities.

Meanwhile, ethnographic evidence suggests a thriving medical pluralism in these communities, with multiple means of maternal care that extend beyond what is contained in the archives. This exclusion impoverishes the historical narrative and perpetuates a narrow view of maternal health practices. In this stage of digital archives and the expansion of datasets for AI, this offers opportunities and challenges in addressing the incompleteness of the archive. While digital platforms may promise to democratise access to information and incorporate a broader range of sources, they also risk perpetuating existing biases if carelessly curated. Startups and other emerging institutions need to thus engage with the ethical implications of data selection and usage of archival material, especially in pertinent areas such as maternal health.




*A summarised overview on the nature of each respective archive*

## Medical chronology in the archives

Holding an authoritative memory of maternal care predominantly through a biomedical lens are these archives housed in national institutions across countries like Zambia, South Africa, and Zimbabwe, and they chronicle the evolution of maternal healthcare, emphasising the introduction and integration of Western medical approaches over time. However, these records marginalise or completely overlook the memory of traditional forms of maternal care practised for generations within local communities. This narrowed focus on biomedical history limits the broader perspective and neglects the diversity of Indigenous knowledge systems and traditional healing practices that have coexisted with and sometimes preceded biomedical interventions. This archival bias skews our understanding of maternal health in the region and also diminishes the significance of traditional practices that continue to play a vital role in the lives of many expectant people.

These gaps in archival representation spill over into how emerging technology institutions approach the relevance of data, which underscores the need for more inclusive historical representation that reflects the full spectrum of maternal care practices in Southern Africa. An additional challenge about conventional paper-based archives is that they point to physical deterioration over time, such as decay, damage from environmental factors (such as humidity, light, and pests), and the fragility of materials. This degradation makes historical records vulnerable, eroding collective memory and creating gaps in our understanding of the past. As this memory deteriorates, it challenges the possibility of reconstructing the archive and further skews an already incomplete representation of history. Preservation efforts are crucial but often resource-intensive, further complicating safeguarding archival memory.

# CHRONOLOGY OF HEALTHCARE IN ZAMBIA ARCHIVES

### 1924-1941

**'The Human Factory'**

Broken Hill Mine Hospital: Mines under the British South Africa Company created a welfare scheme to strengthen miners for mineral extraction. Welfare is biased in focusing on mining areas.

### 1946-1956

**Anglo Belgian Collab.**

Controlling borders to prevent the spread of disease across countries, and importing health volunteers to support healthcare.

### 1952-1955

**Debilitated Orphanages**

Sinde Mission Hospital: Institutional neglect and a lack of funding from the colonial administration. Children suffered from waterborne diseases and others due to poor hygiene.

### 1950-1960

**Fix European Hospitals**

New European Hospital: measures taken to ensure well-equipped health for Europeans

### 1970-1973

**Standardised biomedical provision for women and children**

Maternal and Child Health Policy to frame a concerted effort at reducing maternal and infant mortality

### 1980-1990s

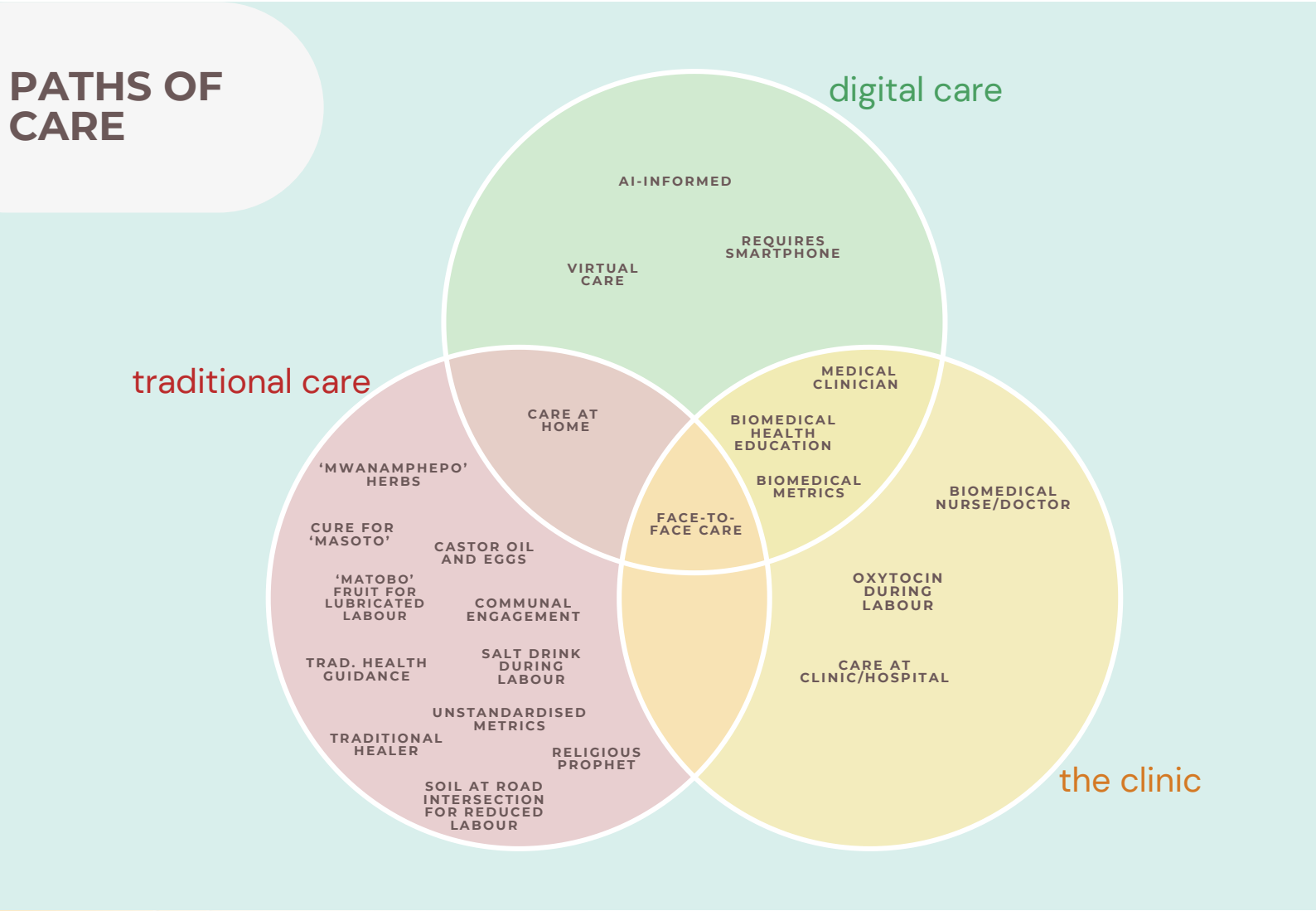
**International intervention supporting Nchanga Consolidated Copper Mines**

Extreme efforts and investments were sourced locally and abroad to support healthcare, including midwifery, in the Copperbelt region and lesser in other parts of Zambia.

*Material sourced from the National Archives of Zambia (Lusaka) and the Zambia Consolidated Copper Mines archive (Ndola)*

The chronicle of healthcare in the National Archive of Zambia and the ZCCM archive illustrated a historical approach to biomedical approaches to health, depicting the gradual institutionalisation and medicalisation of health. Although the evidence suggests that maternal health held lower priority during colonialism, as healthcare mainly served mining areas or people in mining, these records typically emphasise the adoption of scientific intervention, clinical procedures and standardised healthcare practices.

## Personal archives on Maternal Healthcare




Interlocutors narrate the paths of care using their traditional, biomedical, and digital approaches. Although a few characteristics of care from respective areas overlap, traditional care remains the most unstandardised and has the fewest overlaps with digital and biomedical care. This area's elements remain unstandardised as the metrics underpins this knowledge falls outside the scientific scope.

I would like to reflect on some key insights and resources outside of institutionalised archives not managed by institutions for official or public use. Instead, they are repositories of personal histories, relationships, life journeys, and memories that speak to the limiting aspects of conventional archives that we have grown to know. These personal archives were crucial in providing in-depth, nuanced highlights of maternal care's lived experiences and cultural contents. These archives were oral histories detailing daily practices, beliefs and interactions related to childbirth and maternal health. These personal records were passed down through generations, highlighting the continuity and evolution of maternal care, yet the history of this data. However, many expectant mothers were invisible to emerging technologies automating for improved care.

From a focus group of three mothers in Kitwe, the Copperbelt, one learns about the importance of a woman's transition into adulthood, encompassing the biological ability to bear children and the social role of nurturing and raising the next generation. Their stories reveal that the expectation of a baby in a woman's life holds value to familial growth. Whether or not pregnancy is planned, the expectation of motherhood is often seen as a fulfilment of a woman's purpose and a source of respect and status within the community. Thus, pre and post-natal care is critical to sustaining the lives of infants and encompasses a combination of traditional remedies and biomedical intervention to provide a pluralistic underpinning of care. Yet, from these examples shared by Musonda and Ntanda (pseudonyms), one sees that the biomedical aspect takes precedence across patient records and emerging technologies engineered for maternal care.

During her first pregnancy, Musonda's mother was pivotal to her care. She advised on how much physical exercise to undertake, which foods to eat, and the recipe for herbal treatment during her gestation and labour. She also made periodic antenatal care visits to the clinic as her pregnancy progressed. At the onset of labour, her mother handed her a salty drink before going to the clinic for childbirth, which served to shorten her labour and ease the birthing experience. This was similar to Ntanda, whose care combined medical and traditional approaches, the latter being knowledge of practices taught by her mother and grandmother. Ntanda's morning ritual was a root-infused drink taken daily until childbirth.

During prolonged labour, both women undertook a crossroads ritual that comprised a concoction of soil scooped from a road intersection and water in a cup, drank soon before going to the clinic to give birth. This served as an 'oxytocin' elixir. In hospital settings, the hormone oxytocin is used to facilitate labour and control bleeding after delivery. Still, in this case, substances such as soil, sometimes combined with plant root extracts, served as 'oxytocin' elixirs believed to shorten delivery, although there is little evidence on how this impacts post-delivery bleeding.

This forms a part of the broader medical pluralism of other approaches to maternal care. An example comes from Chuma (pseudonym), one of the interlocutors who incorporated DawaMom as part of her care and resided in a high-density compound, John Laing, close to Lusaka's city centre. Although she undertook periodic ante-natal visits at her local clinic, she also employed additional approaches, such as traditional herbs and medicine prescribed by a traditional healer and spiritual prophet, respectively. Her use of spiritual and conventional remedies during her pregnancy was aimed at addressing a physiological void she felt. She followed a prophet's advice to take a whitish powder mixed into her porridge to protect her baby from harm. This practice, while common alongside conventional medicine, can sometimes affect medical test results, potentially resulting in a medical emergency in the event of an overdose of herbal remedies. Despite using these traditional methods, her medical readings were normal during a check-up, though there remains concern about the unknown ingredients' effects. Chuma relied on her mother's traditional herb knowledge for a safer pregnancy and delivery. However, Dawa Health's app, which provides prenatal guidance based on biomedical data, is inaccessible on her feature phone, making it hard to fully use the service. She considered using her husband's phone to access the app, hoping to get more comprehensive health support for her next pregnancy. The area concerning gendered mobile ownership is later discussed in this report.

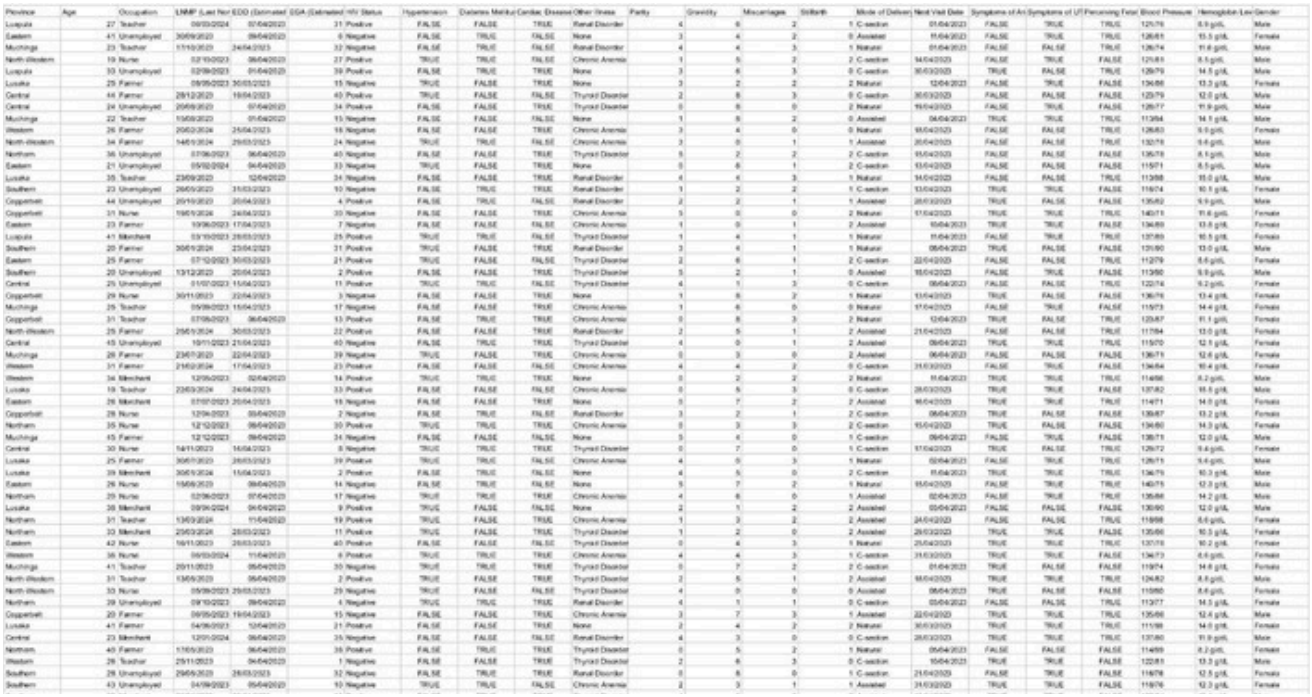
*A market vendor selling herbal medicine at a market. (Source: Lusaka Times)*

## Offerings of Emerging Technology

The narratives from participants are examples of women whose journeys are supported by Dawa Health to improve maternal health outcomes. With the focus on improving pregnancy and childbirth outcomes in Southern Africa, where maternal and infant mortality rates are high, the startup team believes that effective management of these factors can lead to healthier pregnancies and deliveries, reducing the risks of complications such as premature births, low birth weight, and maternal haemorrhage. The startup reaches out to clients through social media campaigns and directs them to their WhatsApp line for initial introductions and appointments. Their DawaMom app uses point-of-care technology to identify patient risk and enable early intervention for high-risk conditions. Additionally, Dawa Health clinicians conduct home visits for routine consultations to gather demographic, medical history, and health indicators as part of their dataset. These data are compared to standardised open-source databases. However, the national government's limited resources and infrastructure for systematic data collection, storage, data collection, management, and cleaning create a lack of readily available datasets in the developing country. Additionally, the minimal investment in digital health technologies and lack of training among healthcare professionals hinder the accuracy and comprehensiveness of recorded health data.

The patient's vitals' readings are populated onto a personalised Dawa Clerk Sheet, then transferred onto an Excel spreadsheet containing a structured dataset along rows and columns. As pictured in the Excel sheet, each row presents a unique data instance, while each column corresponds to a specific feature or variable relevant to the analysis. The spreadsheet contains numeric data such as age, categorical data such as gender, and target variables for data intended for supervised learning to detect a high-risk disorder, for instance.

Since this growing dataset is regarded as too small, a larger dataset from Kaggle becomes relevant for startups like Dawa Health because it provides a large and diverse repository that can supplement local datasets, which often need to be bigger to train robust machine learning models effectively.



*A screenshot of an Excel spreadsheet showing Dawa Health's dataset information, including patient demographics, medical history, and health indicators, is used to develop a machine learning model in healthcare analytics.*

Social scientists can extend the conversation on the need for more localised data to account for limited resources in startups. Due to financial and logistical constraints, startups often need help collecting large datasets. These challenges limit their ability to gather comprehensive and diverse data and have a high potential for unrepresentative bias in the data collected, as it may need to accurately reflect the broader population or the range of conditions the startup aims to address. Open-source data repositories and warehouse platforms such as Kaggle are valuable for startups because this is a platform where scientists across similar fields share their findings and datasets, which become a source of ground reference and context. This data is predominantly from developed countries in the Global North (presenting more research output), informing this standardised context and data trends that startups glean from, and this evaluation or comparison of data from one's country is in comparison with other countries' prevalent trends. Doing so forms part of the goal for startups like Dawa Health to achieve nearly 90% accuracy in AI-generated models.

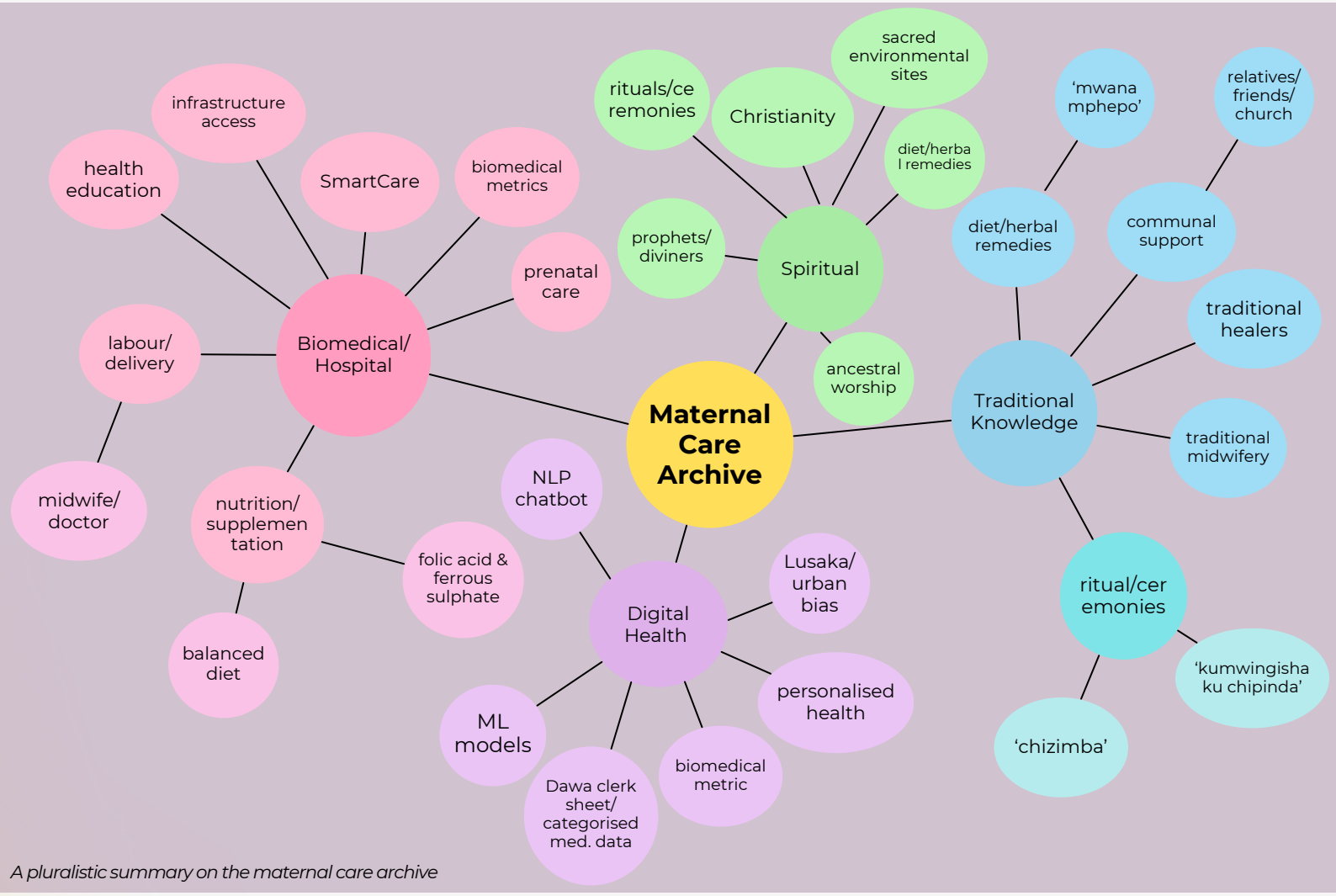
A1 Age

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 1 | Age | SystolicBP | DiastolicE | BS | BodyTemp | HeartRate | RiskLevel |
| 2 | 25 | 130 | 80 | 15 | 98 | 86 | high risk |
| 3 | 35 | 140 | 90 | 13 | 98 | 70 | high risk |
| 4 | 29 | 90 | 70 | 8 | 100 | 80 | high risk |
| 5 | 30 | 140 | 85 | 7 | 98 | 70 | high risk |
| 6 | 35 | 120 | 60 | 6.1 | 98 | 76 | low risk |
| 7 | 23 | 140 | 80 | 7.01 | 98 | 70 | high risk |
| 8 | 23 | 130 | 70 | 7.01 | 98 | 78 | mid risk |
| 9 | 35 | 85 | 60 | 11 | 102 | 86 | high risk |
| 10 | 32 | 120 | 90 | 6.9 | 98 | 70 | mid risk |
| 11 | 42 | 130 | 80 | 18 | 98 | 70 | high risk |
| 12 | 23 | 90 | 60 | 7.01 | 98 | 76 | low risk |
| 13 | 19 | 120 | 80 | 7 | 98 | 70 | mid risk |
| 14 | 25 | 110 | 89 | 7.01 | 98 | 77 | low risk |
| 15 | 20 | 120 | 75 | 7.01 | 100 | 70 | mid risk |
| 16 | 48 | 120 | 80 | 11 | 98 | 88 | mid risk |
| 17 | 15 | 120 | 80 | 7.01 | 98 | 70 | low risk |
| 18 | 50 | 140 | 90 | 15 | 98 | 90 | high risk |
| 19 | 25 | 140 | 100 | 7.01 | 98 | 80 | high risk |
| 20 | 30 | 120 | 80 | 6.9 | 101 | 76 | mid risk |
| 21 | 10 | 70 | 50 | 6.9 | 98 | 70 | low risk |
| 22 | 40 | 140 | 100 | 18 | 98 | 90 | high risk |
| 23 | 50 | 140 | 80 | 6.7 | 98 | 70 | mid risk |
| 24 | 21 | 90 | 65 | 7.5 | 98 | 76 | low risk |
| 25 | 18 | 90 | 60 | 7.5 | 98 | 70 | low risk |
| 26 | 21 | 120 | 80 | 7.5 | 98 | 76 | low risk |
| 27 | 16 | 100 | 70 | 7.2 | 98 | 80 | low risk |
| 28 | 19 | 120 | 75 | 7.2 | 98 | 66 | low risk |
| 29 | 22 | 100 | 65 | 7.2 | 98 | 70 | low risk |
| 30 | 49 | 120 | 90 | 7.2 | 98 | 77 | low risk |
| 31 | 28 | 90 | 60 | 7.2 | 98 | 82 | low risk |
| 32 | 20 | 100 | 90 | 7.1 | 98 | 88 | low risk |
| 33 | 23 | 100 | 85 | 7.1 | 98 | 66 | low risk |
| 34 | 22 | 120 | 90 | 7.1 | 98 | 82 | low risk |
| 35 | 21 | 120 | 80 | 7.1 | 98 | 77 | low risk |

Maternal Health Risk Data Set

*Kaggle's generalised data spreadsheet offers users variables on age, systolic BP, diastolic BP, BS, body temperature, heart rate and risk level. However, this data may be specific to particular contexts, and the information provided is unclear on how diverse the metadata is.*

## The Maternal Care Archive




*A pluralistic summary on the maternal care archive*

Reflecting on the existing medical pluralism, also observed by other scholars (such as Mildnerova, 2010), an archive encompassing maternal health is inherently complex, as it comprises a wide array of practices, knowledge systems and beliefs, all of which coexist within the framework of medical pluralism. In Southern Africa, biomedical interventions, traditional practices, spiritual beliefs and community-based care inform maternal health, all of which have long been integral to the region's healthcare landscape. This pluralistic approach to maternity means an archive or repository reflecting this domain must exceed documenting biomedical records to include oral histories, cultural rituals and the experiential knowledge of traditional birth attendants and healers. The coexistence of these broader health practices shows the need for emerging AI technologies in healthcare to account for this plurality. AI models trained only on biomedical data risk perpetuating a narrow understanding of maternal health, potentially overlooking critical cultural and traditional practices that are essential to holistic care. Technologies integrating diverse datasets could have more inclusive AI systems, ensuring they represent the full spectrum of maternal health practices.

When we compare the DawaMom and Kaggle Excel sheet with the maternal care archive mapped by this image, disparities in data inclusion can be deduced from this analysis. The clusters shown in the infographic summarise the elements of Zambia's existing medical pluralism, which encompasses biomedical knowledge, traditional knowledge, spiritual beliefs, and emerging technologies such as DawaMom. One sees that the dependence on a biomedical approach when compiling health data in this context marginalises salient areas to which people are accustomed and places potential algorithms at the disadvantage of limited automated scope.

## Maternal Health App Compatability

As the global economy deploys digital infrastructure to support life, these potentially exclude marginalised groups (Sassen, 2014), reinforcing the complexities and inequalities of access and usability. Technologies can simultaneously bridge and widen the digital divide, and this social exclusion stems from the universality of digital tools that overlook the needs of marginalised groups (Warschauer 2003). When designing mobile technology for expectant mothers, there lies a tendency to develop a one-size-fits-all approach with an urban bias. DawaMom's constructed interface relied heavily on text-based interfaces. There was also the risk of inaccessible medical terminology to users with limited literacy. Although the team endeavours to have the app available in the key vernacular languages apart from English, namely Nyanja and Bemba for Zambia and Shona and Ndebele for Zimbabwe (Dawa Health has intentions of deploying DawaMom in Zimbabwe), there remains room to interrogate the accessibility of this technology for those with limited reading literacy. From these percentages, 44.8% of women in rural areas reported using the Internet almost daily, with 56.5% in urban areas (ZAMSTATS, 2018). Concerning language, Dawa Health's decision to translate the app's content into Nyanja and Bemba is derived from Zambia's statistics showing the prevalence of Bemba, Nyanja, Tonga and Lozi languages, respectively (Zambia Census, CS0 2010). Yet, this effort to democratise the use of this mobile technology confronts broader challenges that exceed literacy and Internet usage.


*The interface of DawaMom app, displaying a patient's dashboard*

An interview from an interlocutor in Kitwe points to limited reading literacy in Copperbelt province:

*For educated individuals, the interlocutor remarked that technology is beneficial but poses challenges for those who need to be educated. To address this, they suggested simplifying the process; individuals should be able to interpret the content, perhaps with the help of a phone. Many people in the peri-urban and rural communities, including those classified as illiterate, can access modern smartphones with touch screens. They should be able to interpret the content, especially the vocal aspect, across different languages. This will enable everyone, including the illiterate, to comprehend and listen to voice notes or other audio content.*

-Fieldnotes, 11 January 2024

This insight points to broader literacy levels, especially outside Lusaka Province across peri-urban and rural areas with reading limitations. In Zambia's Democratic and Health Survey (ZAMSTATS, 2018), the overall literacy rate of women in rural areas was 54.1%, with 80.5% in urban areas. Those who could not entirely read in rural areas comprised 45.8% in rural areas, with 19.4% in urban areas (ZAMSTATS, 2018). These urban-rural disparities are also reflected in Internet usage, with 3.8% of women in rural areas ever using the Internet versus 24.4% in urban areas.

DawaMom's critical feature, Rudo, a Natural Language Processing (NLP)-powered chatbot through which users pose maternal health queries related to their experience, poses relevant discussion points. Drawing from open-source data, the Dawa Health team's NLP algorithm serves to understand and interpret user queries in natural language, which allows the app to recognise and respond to the wide range of healthcare concerns and questions posed by users. When users input their medical symptoms or questions in natural language via text, the app uses NLP to understand these queries and extract the most relevant keywords and context. The app's NLP algorithms are refined to improve accuracy when continuously updating medical information. While NLP carries the advantage of understanding, interpreting and generating human language, it also carries downsides, such as its susceptibility to biased training data. Ethnographic insight identifies a discordant relationship between vernacular languages and an NLP-driven protocol that relies on historical data that is arguably biased. This discussion prompts whether emerging apps can effectively achieve decolonial AI through NLP, whose models are trained on large datasets that contain biases derived from historical texts reflecting colonial-era perspectives. On the interface, users might effectively use their native language when communicating with the Rudo chatbot. Still, the biases embedded in NLP might produce results that perpetuate or amplify discriminatory patterns. Some of the numerous colonial legacies connected to NLP include cultural and language bias: NLP models may struggle with vernacular languages such as those incorporated into DawaMom, as these dialects are poorly represented in training data, often marginalising languages from this region. As such, the issue of language divides remains and reinforces linguistic hierarchies.

The compounding challenge of maternal health apps thus concerns human-computer interaction affecting women in the Global South, and this involves patriarchal design limitations and the gendered aspect of mobile phone ownership. Unpacking design within a patriarchal society, Sultana and colleagues (2018) draw on empirical data in rural Bangladesh to identify the design and systemic challenges of rural women and the limitations of current human-computer interaction for development strategies that serve them. The software development team at Dawa Health, primarily male, and designing their product outside their fieldsite into which it is later deployed, overlooks the needs of direct users (women) and the broader community and the patriarchal context in which these women live. As such, Sultana and colleagues (2018) also highlight the importance of designing for third-party intermediaries who influence women's lives.

Although the DawaMom concept offers translation into a few predominant vernacular languages, this faces not only literacy disparities but systemic challenges such as extreme poverty, the lack of financial control by women and societal norms that prioritise male decision-making in economic matters. Anecdotal evidence from an interview with a teacher in the Southern Province of Zambia highlighted that approximately 8 out of 10 women possibly do not own a mobile phone, relying either on their male partner's or a relative's, because of gendered attitudes preferring mobile phone ownership for men (see Murphy et al., 2011; Porter et al., 2020). Reflecting on these disparities, conversations and the concept of DawaMom, the limitations of this design point to its usability within an urban bias and along a literate group of users that has easier access to the Internet. Furthermore, should the future of DawaMom require a subscription, it narrows its accessibility to an economic class that affords it.

# CONCLUSIONS

## Bias in Knowledge Storing and Archives

The findings from this research point to the limitations of an archive determined by its traditional practices that include or exclude knowledge pieces. Although seemingly vast in their content, archives are limited in containing fragments of life, but not its entirety. Reflecting on critical understandings of the archive (Mbembe, 2002:21), these subjective fragments "create an illusion of totality and continuity," a phenomenon that cuts across our era of digital repositories prepared for AI. This totality of biomedical framework that informs the memory of and conceptualisation of our health conceals multiple other ways of life that otherwise pursue health from a different community perspective. One insight from the Dawa Health team points to shortcomings when relying on open-source metadata, such as the fact that you cannot verify other participants from open-sourced Kaggle, and the context from which it came is obscure. While it is easier to control bias from data collected by the Dawa Health clinician, as this data can be revised and verified for authenticity, verifying data provided by an open-source platform poses many impediments. Another shortcoming is that while countries possess health data, mostly paper-based, this still requires cleaning. Hence, startups depend on open-source data. The means of how it is stored in hospitals, i.e., physical records, can vary depending on who has written them and how they have been presented.

## Limitations of Biomedical Approaches

Dawa Health's datasets are structured around the principles of evidence-based medicine, which prioritises data from clinical trials, meta-analyses, and systematic reviews to use this evidence for clinical decision-making. Historically, knowledge and the curation of health-related repositories indicate a prevalent focus on epidemiological aspects, including the prevalence, risk factors, and incidence of diseases. This focus helps researchers and health stakeholders identify patterns and trends but may neglect the socio-cultural and environmental factors influencing health. As evidenced by the spreadsheets informing Dawa Mom, one gleans the tendency toward reductionism, where complex health conditions are broken down into simpler, measurable components and can result in a narrow view of health centred on biological factors at the expense of holistic perspectives that include social, psychological, and environmental determinants.

These reflections show the limitations of standardisation and universality. When maternal health data are standardised to create universal benchmarks, this assumes that health indicators and treatment responses are consistent across different populations and can lead to a one-size-fits-all approach, potentially overlooking individual and cultural variations encompassing various epistemic approaches.

Regarding selection and inclusion criteria across all institutional archives studied, one observes that the scope of knowledge or material on maternal health falls within epidemiological and biomedical insights, as archivists decide what materials to preserve based on perceived historical, cultural and evidentiary value often reflect certain biases or cultural perspectives. Similarly, datasets in biomedical contexts are curated based on what developers consider clinically relevant or scientifically valid, which privileges specific types of data, such as clinical trials and biomarkers, and primarily excludes alternative knowledge systems or non-quantifiable aspects of health.

Speaking to an archivist at the ZCCM archive revealed that archives often use standardised systems for cataloguing and classification, which can homogenise diverse materials into predefined categories, which marginalise unique or non-conforming items. Similarly, by creating standardised data in open-source platforms, categorisation data such as diastolic codes and health indicators that overlook the complexities and contextual nuances of individual health experiences can perpetuate a reductionist understanding of health. When reflecting on preserving knowledge, one deduces that conventional archives preserve a particular narrative or aspect of history, often prioritising certain voices over others, which shapes public memory and histori-

ical understanding. In our digital age, we also observe a narrow focus on biomedical data, whose datasets preserve and perpetuate a specific view of health and illness that is mainly rooted in Western scientific paradigms. This eventually plays a role in healthcare practices and policies to the detriment or expense of integrating broader, culturally diverse perspectives on health.

In the broader practices of institutional archiving, one sees that archived materials are often controlled with certain restrictions on who can access what information, which can limit diverse interpretations and uses of the archive (insert description on how you accessed these archives). As such, access to biomedical data is similarly controlled often by institutions and corporations. Smaller startups relying on generalised datasets derived from external institutions have no control over such repositories, which can limit who benefits from the data and whose health narratives are recognised and addressed. The trajectory and ownership of collected data by startups remain opaque to the researcher as startups employ.

## Recommendations: 'Box Breaking': Data, Dismantling and Developing

A workshop organised by the researcher in Lusaka concluded this project, hosted at Bongo Hive's Co-Working space, for startups and stakeholders in Zambia interested in AI at Hive Co-Working. The workshop included discussions on the importance of representative datasets. The concept of this workshop was to dismantle the commonplace models whose inner workings, depending on unrepresentative data, are invisible or incomprehensible to the user – the black box. Unpacking the weaknesses of these obscure models, Loyola-González (2019) refers to black-box models as those providing outputs based on complex algorithms without offering insight into how those outputs are generated. While such models may produce accurate predictions, the rationale behind those decisions remains obscure, making it difficult for users to understand or trust the results (Loyola-González, 2019).

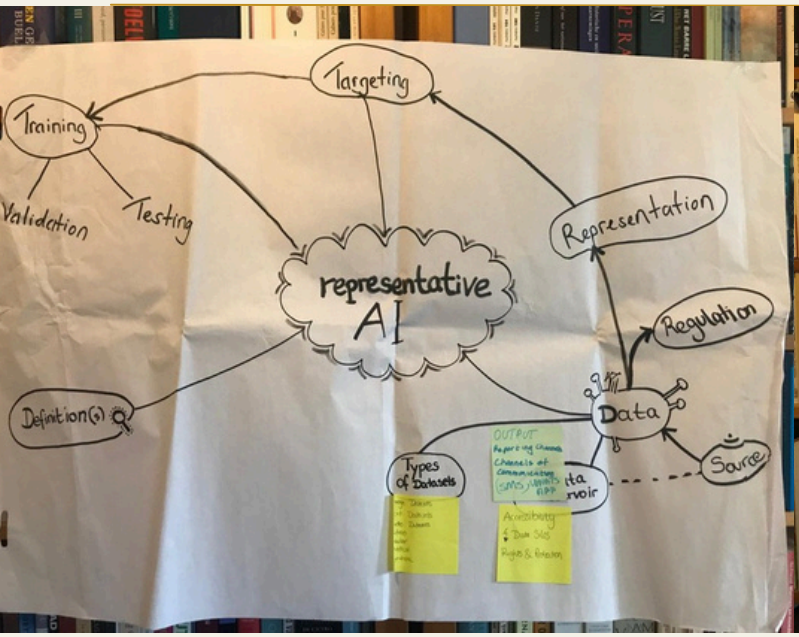
Given the challenges of compiling large localised datasets that lead to emerging startups' dependence on open-source standardised databases, this sparks questions on data representation and new trends measured against hegemonised data.

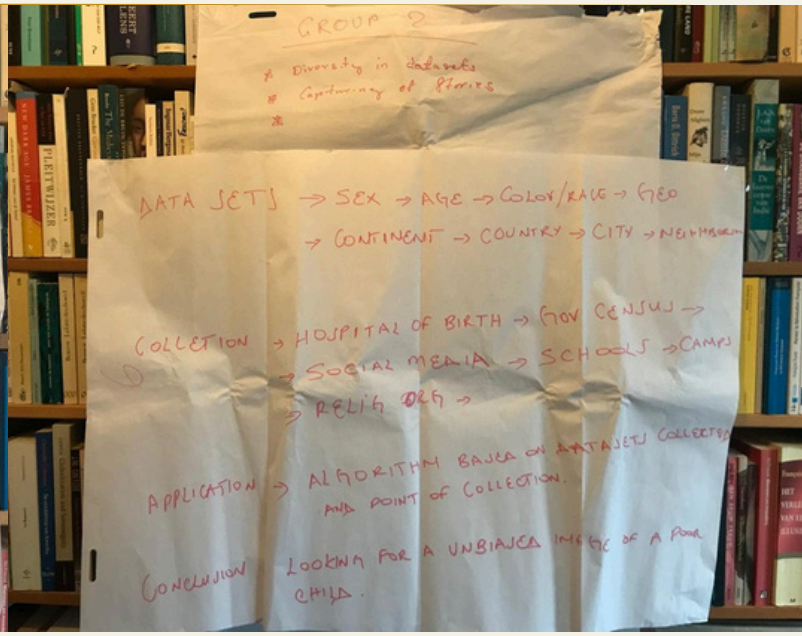
Over an entire afternoon, 'box-breaking' or breaking the 'box' allowed emerging entrepreneurs, Zambian government representatives and policy stakeholders to hold panel discussions on their experience with sourcing data for their startups, drawing data management legislation and brainstorming on improved ways of conceptualising inclusive data and developmental AI, including that for healthcare.

The key component of the workshop was a storyboarding session, during which groups of participants reflected on possible means of addressing inherent bias arising from data collection practices. The storyboarding method effectively uses visual narratives for stakeholders to organise their ideas through various means, such as drawings, flow charts, mind maps, or other suitable means for each group (see Walker et al., 2013).


*'Box Breaking': Data, Dismantling and Developing event flyer: for startups and stakeholders in Zambia interested in data and AI development.*


*Images taken from the 'Box Breaking' workshop at Bongo Hive's Co-Working Space. Participants broke into groups to create storyboards that reimagined data practices and improved AI.*




This exercise brought participants together into one room who otherwise think far apart. This made it much easier to identify gaps and think collectively about addressing them. Drawing insight from two storyboard discussions, participants made the following points regarding inclusive data:

- Broadening the scope from where data is sought beyond open-source platforms
- More specificity on the types of data (sets) used for machine learning
- Employing systematic and continuous data collection and management over time - this includes perspectives outside formal institutions.
- Algorithms should reflect the dataset(s) from the location where data is collected.
- Dismantling data binaries by including a wider scope of difference, e.g. gender and skin tone
- Data regulation and legislation (from guiding bodies such as ZICTA) should model frameworks on data practices from a grassroots approach, considering voices from communities.
- Have a context-specific definition of 'artificial intelligence' that is smart enough to identify local differences.

As practitioners such as startups in the region aim to bridge maternal health risk through digital technologies, their approaches to data should be broader than conventional archiving approaches. The memory and historical data from which our algorithms emerge must consider knowledge that is otherwise not on paper but lies within marginalised knowledge sources. Although traditional health practices remain unappreciated because they employ non-scientific metrics, their impact on biomedical metrics indicates that they need to be incorporated into the broader health data scope.

Scholars such as Miller and Horst (2020), Povinelli (2017), Mbembe (2002; 2020), Hamilton and Cowling (2020), Benjamin (2019) and others provide critical insights into the implications of normative data in AI, universalised data archives and the paternalistic approach to digital technology. The ethnographic visibility of pluralisms of maternal care in Zambia remains invisible to the automated algorithm and those creating it for better care. Understanding digital technologies within specific cultural contexts is essential and challenges the notion of universal applicability of data norms that AI relies on. I refer to Povinelli's concept of "geontopower", which critiques how data systems enforce existing power structures, reinforcing colonial and capitalist ideologies through supposedly neutral technology. Valuable work on necropolitics (Mbembe, 2020) further highlights how AI and digital technologies can perpetuate exclusionary practices, where certain groups of people are rendered invisible or disposable within global data archives. Anthropological engagement thus illuminates how normative data practices in AI can inadvertently reinforce power imbalances, coaxing us to deter from paternalistic approaches towards more inclusive and contextually sensitive designs in digital technology.

The Artificial Intelligence in Maternal Health in Zambia (AIMZ) project is crucial in fostering a critical examination of universalised data and the normative and mundane components that will shape the future of automated maternal care. AIMZ provided a platform for Dawa Health, enabling a nuanced analysis of how standardised data can be contextualised within Zambia's specific socio-cultural and economic landscape, ensuring that the development of AI-driven maternal care systems is relevant and sensitive to local needs. Furthermore, AIMZ has encouraged the relationship between startups and regional governance bodies to collaborate on the broader implications of data usage across various sectors of life in Zambia. This partnership enhances the efficacy of external care and prompts a holistic approach to regional data governance and development.

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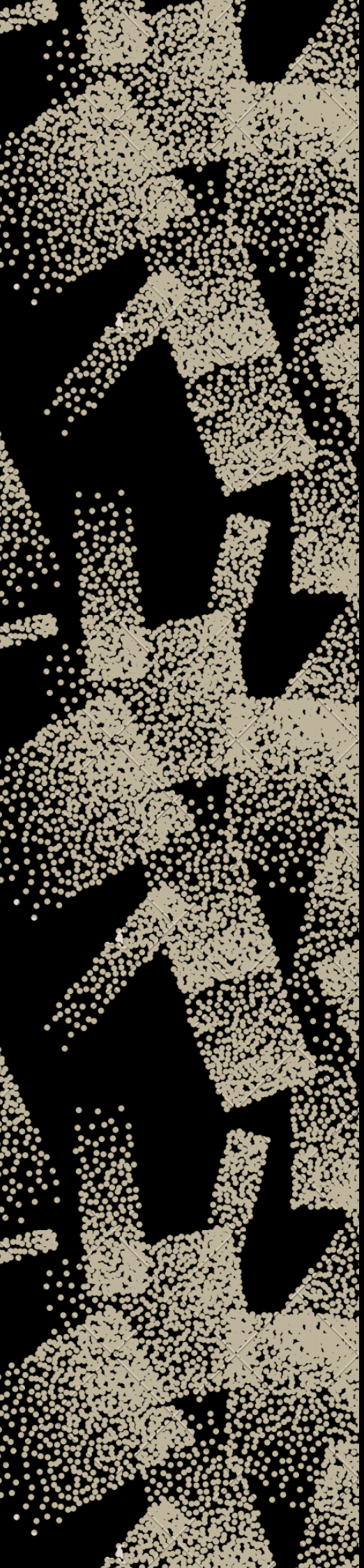


**Min’enhle Ncube**

Researcher & Applied Anthropologist

+260 773 808 996 / +27 67 793 2956 / +31 68 7235711

minenhle.ncube@alumni.uct.ac.za

Department of Social Anthropology, University of Cape Town

www.mimincube.com