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Systematic review on challenges for integration of health management information systems in enhancing HIV and AIDS estimation and monitoring across Sub-Saharan African countries

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Abstract

Sub-Saharan African (SSA) countries suffer from high disease burdens, including HIV and AIDS. Data from the national Health Management Information System (HMIS) to inform HIV and AIDS estimates are relatively poor, negatively impacting monitoring of the epidemic. The challenge necessitates a need for increased integration and functionality of the national HMIS to deliver timely and reliable information to healthcare workers and managers. This study investigates how the challenges to effective integration of HMIS in SSA countries impact the availability of good quality HIV estimation and monitoring. We conducted a systematic review of relevant publications from 2008 to 2024. The findings show that, despite the efforts by SSA countries, challenges continue to impede the meaningful utilization of HMIS to produce good quality HIV estimates. The challenges are attributed to technical, organizational and behavioural factors, such as limited integration of HIV programme components, poor data quality, inadequate resources, weak leadership, lack of accountability, and limited enforcement of HMIS regulatory frameworks. Hence, the systems hardly respond timely to the expanding data requirements of the HIV estimation tools and monitoring requirements. The study recommends SSA governments and partners to support HMIS development and on-job training in data collection, cleaning, and analysis.

1. Introduction

Improved health systems performance is related to well functional Health Management Information Systems (HMIS) providing timely and reliable information to implementers and managers at all

levels of the healthcare system to detect and facilitate prompt response to unusual disease trends [1].

Such decisions influence policy, planning, monitoring and evaluation of health programmes and outcomes. HMIS has been described as the subsystem of the health system, which is comprised of all information processing actions as well as the associated human or technical actors in their respective information processing roles [2]. This characterization is well depicted by the Performance Routine Information Systems Management (PRISM) conceptual framework. It describes the relationship between the determinants of the Routine Health Information Systems (RHIS) and the results of the healthcare system (outputs and outcomes) [3].

Integration of HMIS is widely recognized as a means of enhancing HMIS functionality for improved decision making. According to a study by Measure Evaluation [4], the Healthcare Information and Management Systems Society (HIMSS) described integration as "the arrangement of an organization's information systems in a way that allows them to communicate efficiently and effectively and brings together related parts into a single system." Integration, therefore, allows organization's information systems to communicate efficiently and effectively, bringing together related parts into a single system. It is important because it allows for the seamless and timely extraction of data and information from various sources for utilisation in different health related data driven processes.

Studies have supported the role of management information systems in optimizing business performance by improving the quality of managerial decisions [5]. Therefore, calls have been made for improved integration of existing health information systems to enhance delivery of health services. Integration has, therefore, become imperative for many countries because of the need for an infrastructure that uniformly connects distributed and fragmented health records to deliver value added information to healthcare [6]. However, the lack of consensus among researchers regarding the appropriate mix of approaches to achieve optimal integration has created challenges in the integration of health data systems [7]. Varied interpretations of integration have made it difficult to measure the desired results, prompting for a common language and framework for integration in research and practice [8]. A systematic review discovered 70 phrases, and 175 definitions associated with integration used interchangeably to refer to integrated health services, integrated delivery networks, integrated healthcare delivery, integrated HMIS, and many other forms of integration in the health system [8].

HMIS integration in Sub-Saharan African (SSA) countries has also been subject to reviews in the quest by the countries for better evidence to understand and monitor national disease burdens. In a review of 32 different studies on the approaches to integration, findings suggest the need for a more efficient methodology to invoke various services for aggregating health data, as well as a more effective way to integrate the aggregated health data to support collaborative utilization [9]. Despite the challenges, Ministries of health and their respective HIV programmes continue to engage partners annually to produce national estimates of HIV epidemic trends using the Joint United Nations Program on HIV and AIDS (UNAIDS) supported Spectrum and Estimation and Projection Package [10]. The national HMIS, therefore, continues to be in the spotlight to provide the necessary good quality datasets on time for the estimation processes.

Various studies have been undertaken to highlight the challenges with integrated HMIS as well as the methods of utilizing integrated health

data [9]. Unlike previous studies, which have focused largely on investigating integration challenges, this study explores the challenges and investigates their impact directly on HIV estimation and monitoring in SSA countries. It addresses the knowledge gap by specifically highlighting how the challenges to effective integration in resource constraint settings in SSA countries have impacted the production of good quality annual HIV estimates for improved monitoring. It extends the existing body of knowledge to identify interventions that can help address the challenges.

HIV and AIDS continue to pose serious health burden to SSA countries that carry 25.6 million (66%) of the global total of 39 million women and men living with the disease today [11]. Access to good quality and timely data for effective monitoring of the epidemic is, therefore, a priority, but the changing methods of estimation and issues with data sources present challenges [12]. In many places, including SSA countries where progress on the global AIDS targets has been most limited, the underlying data from the national HMIS to inform the estimates are the weakest [13]. It has led to calls for increased functionality of data systems to improve monitoring of the disease.

The United Nations General Assembly Special Session Declaration of Commitment (DOC) on HIV and AIDS, 2021, to end AIDS by 2030 as public health threat is a key factor underpinning the indicators and targets those countries must continue to monitor. HIV prevalence, incidence, AIDS related deaths, number of people living with HIV and in need of treatment, the impact of treatment and the number of AIDS orphans are some of the major indicators that are used to assess the burden and transmission dynamics of the disease. Key targets, among others, to be achieved by 2025 are the "Combination HIV prevention for all", "95–95–95 for HIV testing and treatment" and "End to pediatric AIDS and eliminate vertical transmission" [14].

Faced with the requirement to meet the targets at national and global levels, ministries of health in SSA countries have taken up the challenge to monitor their respective national AIDS epidemics through modelling and estimation. Modelled HIV estimates and projections for many countries provide the basis for assessing the status of the current and future AIDS epidemic. They also provide a mechanism for countries to set their targets and plan interventions. Monitoring the AIDS epidemic through disease modelling in SSA countries has become imperative and put the integrated HMIS in the spotlight, with partners demanding more functional systems that serve the data needs of the annual modelling processes. This is particularly important given that the underlying data sources for models have expanded over the past decades presenting challenges as well as opportunities [12]. Recent requirements for the models require countries to utilize the results from population-based surveys and district level surveillance data into Spectrum, EPP and Naomi estimation models [14]. UNAIDS provides support annually to countries to produce the estimates which can be disaggregated by age and sex [15].

2. Method

This systematic review was conducted and reported based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines [16], leading to the identification of relevant national programme documents and articles on the subject matter.

2.1 Literature search process

The review was conducted using a systematic search strategy, sourcing articles from two online databases: PubMed and Google Scholar. These databases offer extensive repositories rich in publications related to HMIS integration and

HIV/AIDS modeling. The search was restricted to English-language articles published between 2008 and 2024. The process adhered to the PRISMA checklist and flowchart, encompassing four phases: identification, screening, eligibility, and inclusion.

2.2 Identification

The search criteria were based on specific keywords related to HMIS. Table 1 presents the final set of search keywords used to explore both databases.

Table 1. Keywords used in search process by thematic areas.

Thematic Areas	Keywords
Area 1	HMIS Integration, Health Information System
Area 2	Health systems, HIV and AIDS monitoring
Area 3	HIV and AIDS Modelling, HIV Estimation

2.3 Screening and eligibility

Initially, the authors independently screened articles to remove duplicates and resolved any discrepancies through mutual consensus. Subsequently, the articles were filtered based on the inclusion and exclusion criteria. Next, the authors reviewed the titles and abstracts of the remaining articles to eliminate irrelevant publications. Finally, the full texts of the remaining publications were thoroughly reviewed by the authors using the eligibility criteria to finalize the selection.

2.4 Inclusion and exclusion criteria

The study reviewed articles and other documents that meet the following criteria: (i) Published between 2008 and 2024 in peer-reviewed journals; (ii) Abstracts accessible through the search databases; (iii) Written in English; (iv) Focused on HMIS integration and HIV/AIDS modeling in SSA countries. Publications that were not relevant to the topic, written in languages other than English or published out of the designated period were excluded from the review.

2.5 Data extraction and analysis

Microsoft Excel was used to create a data extraction form for recording and reviewing data from the selected publications. Table 2 depicts a summary of the Technical, Organizational and Behavioral challenges reviewed.

2.6 Literature search results

Figure 1 depicts the selection and exclusion process for publications included in this review. The initial database search identified 93 publications, with 30 retrieved from PubMed and 63 from Google Scholar. After removing duplicates (n = 15), 78 unique articles remained. These were then filtered based on inclusion and exclusion criteria (1–3), resulting in the removal of 10 irrelevant publications. The remaining 68 titles and abstracts were further reviewed against the inclusion and exclusion criteria (1-3), leading to 58 publications being deemed eligible for full-text review. During the eligibility phase, 18 publications were excluded as they did not address HMIS integration or HIV/AIDS modeling in SSA countries. Ultimately, 40 publications were included in the review, following consensus from all authors.

3. Results and Discussion

Previous studies reviewed [3], [8], [25], [35] in this exercise helped demonstrate the related studies. However, their findings diverge from this review, which explored how challenges with integration specifically impacted HIV estimation and monitoring in SSA countries. Based on the key words used to select the documents, three challenges were identified and categorized.

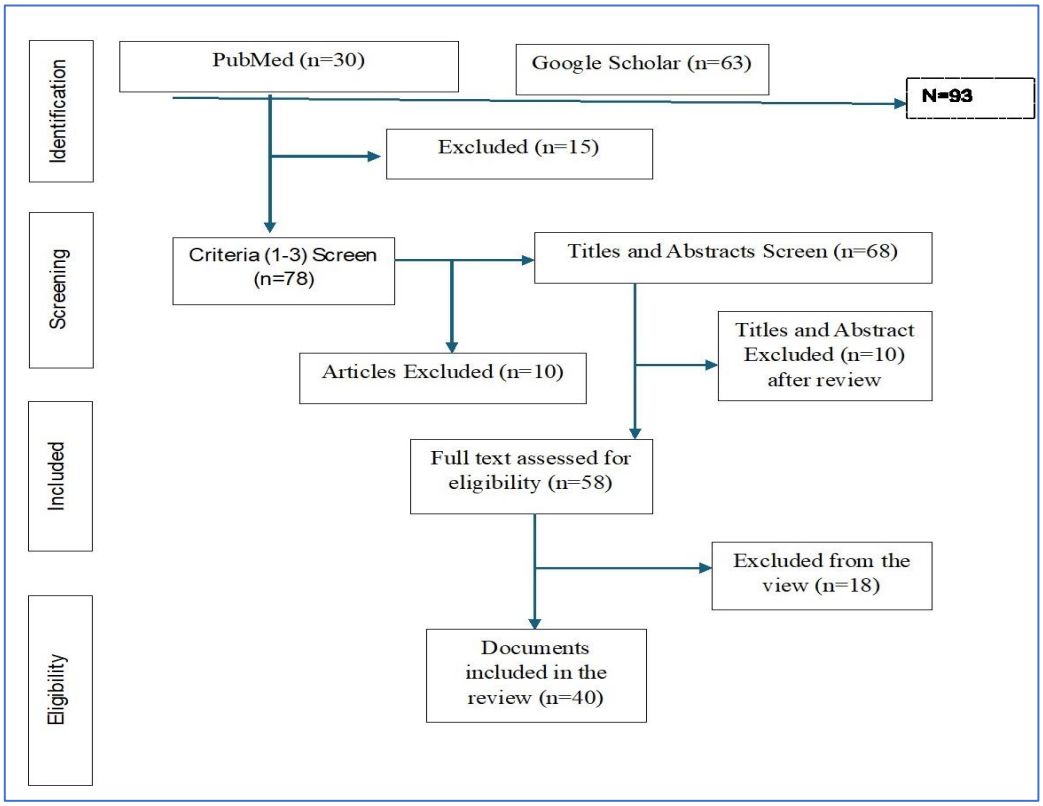

Figure 1. Chart showing the selection process of documents.

3.1 Categories of challenges

3.1.1 Technical challenges

Integration across different domains in SSA and many other developing countries has been approached by default as a technical issue, primarily involving technicians and technical components [17]. A review by Peng et al. [18] opined that integration is optimized if the approach conforms to interoperability standards, including standard conformance, interoperability level and integration effort. They are vital for enabling the exchange, interpretation and sharing of health data. New emerging technologies, such as Artificial Intelligence (AI) and Machine Learning, have huge potentials to change how integrated HMIS are managed and utilized. They have contributed to improving speed, and accuracy of data processing. HMIS practices, such as data capture, healthcare data management, data governance, confidentiality, and health information management workforce training and education, have been impacted by AI [19]. In South Africa, AI and Machine Learning have been used in the health information system to identify HIV patients at risk of disengaging from care and failing to achieve viral suppression [20].

Technical and operational challenges with HMIS fragmentation in Tanzania prompted the Ministry of Health to establish a health information interoperability layer called the Health Information Mediator (HIM) to harmonize the existing national health information systems across public institutions to facilitate health information exchange [21]. The approach witnessed the transition from paper-based registers and the integration of vertical programme-based information systems through the implementation of the second version of the District Health Information System (DHIS2)

with technical assistance from the University of Dar es Salaam (UDSM), DHIS2 lab [22], University of Oslo, and HISP Tanzania. UDSM presented the customized web based DHIS2 to the Ministry of Health and was accepted as the integrated HMIS in Tanzania [23]. Despite the successful rollout of the DHIS2, implementation continues to encounter technical challenges, including slow response time, inadequate Information and Communication Technology (ICT) infrastructure, delayed upgrades, limited internet, and inadequate training [24].

Ethiopia has been implementing standardized HMIS over many years, but less than one-fifth of the health facilities utilize HMIS data [25)]. Duplicate data collection, HMIS infrastructure related challenges, and limited capacity challenges with health information technicians have been cited as major challenges to health data utilisation [26].

In Sierra Leone, the Integrated HMIS faces many technical challenges, including poor data quality and technical expertise that has resulted to the gross underperformance of the national HMIS in meeting the requirements of meaningful data use [27]. The integrated HMIS in Zimbabwe is reported to have faced similar challenges often with inaccurate, incomplete, inconsistent, and late submissions which are associated with the use of different tools for data collection and lack of adequate training for HMIS staff [28].

3.1.2 Organisational challenges

This review discovered studies which highlight how organisational challenges have impacted the performance of integrated HMIS. Organizational factors include management, governance, planning, training, supervision and finance [3]. The absence of a good central coordination mechanism, weak leadership, limited enforcement of regulatory HMIS frameworks, and insufficient resources have been observed as serious organisational challenges to HMIS integration in resource constraints settings [29]. Challenges hindering HMIS utilisation in Kenya have been attributed to lack of management support, poor skills among the users, lack of power backup and organisational resistance to change [30].

In Uganda, limited human and financial resources, poor culture of accountability, lack of incentives for performance, and vertical health programs have been pointed as key challenges to the timely collection and reporting of reliable data from the HMIS [31]. Although result-based initiatives and tools like the HMIS have been implemented in Uganda, accountability largely focuses on monitoring information related to budget preparation, execution and reporting. Inadequate human and financial resources, lack of incentives and supervision, and lack of standard operating procedures on data management have also been referenced as significant challenges affecting HMIS performance in Tanzania [1].

In Tanzania, the fragmented programme structure (PMTCT, NASHCoP, and TB), existence of parallel recording and reporting systems, and the slow pace of transition from paper-based to electronic system have contributed to the existing poor quality data issues (inaccuracies and incomplete records) and reduced the effectiveness of the HMIS [32]. Over reliance on external donor funds to undertake periodic data quality reviews has exacerbated the problem.

Due to organisational factors in Nigeria, the government struggled in the deployment of its information systems to support public health strategies despite an early standardization effort to include a more predictable identification system of health facilities across Nigeria through a master facility list [33], [34]. The master

facility list allowed the allocation of unique identifiers to health facilities to advance the integration and interoperability of health systems that contain information on different health facilities in the country.

3.1.3 Behavioral challenges

Behavioural factors are a key determinant of the Performance Routine Information System [3]. Challenges with the components can emerge because of knowledge gaps, departmental tensions, power and influence and the effects of politics on the integration processes.

A web based DHIS2 was scaled out nationally in Cameroon by the Ministry of Public Health as the backbone of the national HMIS to collect routine health data from facilities [35]. The roll out was followed by nationwide training on data capture directly into the electronic system. Although the system was well established technically, the manner and culture of collecting and submitting data posed challenges for the performance of the system. Data collection and information management was viewed as an institutionalized routine to be performed by staff in fulfilment of their responsibilities but never considered by healthcare providers and management as an important resource for decision making and monitoring of health outcomes.

A report on the challenges to integration in Zanzibar, Tanzania, indicate conflicts of interest among partners, lack of enough knowledge on health indicators, relatively low education levels and the effects of politics, power and influence as major factors that influenced behaviours and the integrated system [36], [37]. These factors were believed to further bring about disproportionate decisions among the central actors leading to lots of tension in the integration process.

Due to political interference and technical issues, less than one-fifth of the health facilities in Ethiopia utilize HMIS data despite the country implementing standardized integration of HMIS over a long period of time [25]. Studies in Ethiopia observed that behavioural factors including poor documentation, skills gap, and lack of experience was responsible for the poor data quality in the HMIS [38].

3.2 Implications for HIV estimation and monitoring

There have been several reviews of the approaches and methods for measuring the HIV and AIDS epidemic. One of the reviews has contended that the approaches to measuring the epidemic have evolved over the past 30 years in response to improvements and changes in the data requirements that inform the process [12]. Earlier estimates and projections were informed by extrapolating the trends in the numbers of incidents with AIDS cases reported. These approaches were viewed with caution due to the pitfalls in using extrapolation technics. Current approaches to obtain national HIV modelled estimates have evolved over the years and processes are transparent and consultative. The input datasets from the national HMIS are presented to partners and discussed for validity and accuracy.

The estimation processes have been taking place in SSA countries within a challenging context of integration and resource constraints with high levels of HIV disease burden. UNAIDS and other development partners support Ministries of Health and associated HIV programmes annually to produce the national estimates of HIV epidemic trends using the Spectrum and Estimation and Projection Package [10] and Naomi model [14]. With the underlying data sources for the estimation models expanded over the past three decades [12], national HMIS

Table 2. Summary of identified challenges.

Categories of challenges	Description
Technical	• Slow response time, inadequate ICT infrastructure, delayed upgrades, limited internet and training are responsible for low system performance [24]. • Duplicate data collection, limited HMIS capacity challenges with health information technicians have been cited as major challenges to health data utilisation [26]. • Poor data quality and technical expertise has resulted in the underperformance of the national HMIS in meeting the requirements of meaning data use [27]. • Inaccurate, incomplete, inconsistent, and late submissions associated with the use of different tools for data collection have been sited [28].
Organisational	• Weak leadership, limited enforcement of regulatory HMIS frameworks, insufficient resources and the absence of good central coordination mechanisms have been observed in HMIS integration in resource constraints settings [29]. • The manner and culture of collecting and submitting data posed challenges to system performance [36]. • Lack of adequate training for HMIS staff to march systems upgrades and evolutions [28] • Limited human and financial resources, poor culture of accountability, lack of incentives for performance, and vertical health programs have been pointed to as key challenges to the timely collection and reporting of reliable data from the HMIS. Although result-based initiatives and tools like the HMIS have been implemented, accountability largely focuses on monitoring information related to budget preparation, execution and reporting [31]. • Lack of incentives and supervision, and lack of standard operating procedures on data management have been referenced as significant challenges affecting HMIS performance [1]. • Fragmented programme structures and existence of parallel recording and reporting systems and the slow pace of transition from paper-based to electronic system have contributed to poor quality data issues (inaccuracies, incomplete records) and reduced the effectiveness of the HMIS [32]. • Reliance on external donor funds to undertake periodic data quality reviews and management of the integrated HMIS has exacerbated existing challenges [34].
Behavioral	• Behavioral factors including poor documentation, skills gap, and lack of experience are responsible for the poor data quality in HMIS [38]. • Although the systems may be well established technically, the manner and culture of collecting and submitting data in some countries may pose challenges for the performance of the HMIS. Data collection and information management is viewed as an institutionalized routine to be performed by staff in fulfilment of their responsibilities but never considered by healthcare providers and management as an important resource for decision making and monitoring of health outcomes [35]. • Conflicts of interest among partners, lack of adequate knowledge on health indicators, relatively low education levels and the effects of politics, power and influence as major factors that influenced behaviors and the integrated system. These factors were believed to further bring about disproportionate decisions among the central actors, leading to lots of tension in the integration process [36], [37]. • Political interference into technical issues has led to underutilization of the HMIS despite some countries implementing standardized integration of HMIS [25].

have come in the spotlight with partners calling for more robust and functional integrated systems to provide the necessary good quality datasets on time for the estimation processes. Poor quality of data is a distortion of reality and when used in the HIV estimation models produce misleading results. The problem is compounded when the input data sets are not produced on time leading to delays by countries to produce the estimate results in time to meet global timelines of reporting.

Findings from an evaluative study in Ethiopia indicates that the definition of HIV and AIDS indicators in the HMIS adversely impacted the quality of data used for HIV and AIDS monitoring [39]. Although the HMIS guidelines emphasize DHIS2 in ensuring the production of good-quality data, the system could not produce useful data because of flaws in the definition of indicators in the HMIS. ICT and other related resources were revealed to be critical barriers to the successful aggregation of national data used in the models.

Sparse data in Anti Natal Care (ANC) facilities in Malawi led to serious limitations using the Naomi model in a small area regression to produce HIV prevalence, incidence and ART Coverage [14]. With the increasing use of spectrum and the Naomi models by SSA countries to estimate the HIV epidemic, data quality issues have fuelled contentions directed at the modelled results leading to calls to validate the results with estimates from other methods. In a comparative study of multiple methods of estimating HIV incident in Kenya and Uganda [40], triangulation of methods and results were recommended to determine best-supported estimates to guide programs. These contentions have recently become common place as ministries of health have to decide on the best estimates to report on the global HIV targets.

This review has been less exhaustive in terms of the number of documents reviewed and information analyzed. It has focused on studies published in English, thereby leaving behind substantial information from other studies not conducted in English. Future research is therefore recommended on the subject matter to demonstrate peculiarities in other countries that may have been left out and to showcase how the innovative nature of this study can influence development in health informatics and policy formulation in SSA Africa.

4. Conclusion

Integration of HMIS has been taking place over many years in SSA countries to improve on the availability and quality of health information for better data use in various data driven processes including policy formulation, strategic planning and HIV and AIDS estimation and monitoring. Ministries of health and development partners in these countries recognize the importance and have pursued collaborative efforts to improve on the systems. However, this review found that, despite efforts by these countries, technical, organizational, and behavioural challenges continue to limit performance of the information systems.

Fragmented HIV programme structures associated with parallel recording and reporting systems and the slow transition from paper-based to electronic systems have been cited as contributing to the continued poor quality data issues (inaccuracies and incomplete records) encountered by the integrated systems. The systems have also not been able to catch up with the expanding data requirements of the estimation models. Poorly defined indicators in the integrated systems have led to adverse data quality issues, and in some countries led to partners questioning the modelled results. Inadequate resources, weak leadership, limited

enforcement of regulatory HMIS frameworks, and the lack of accountability have also been observed as major challenges.

To address these findings, SSA countries should continue to focus on strengthening their national HMIS. This would, however, require commitments from governments and partners to agree on efforts and strategies to apply international HMIS standards to national systems. Such strategy has been applied in South Africa, Tanzania, and Botswana. At a minimum, data quality improvements are critical to the relevance of the HMIS and should be pursued by scaling up regular audits of the routine health information system, and on-the-job learning to improve on data collection, cleaning and analysis. Since many data quality improvement processes are reliant on donors, governments should consider making budgetary provisions for the long-term sustainability of the national HMIS. South-south learning cooperation, including visits to understudy high performing systems in SSA, may be required.

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Mohamed Turay	[ORCID: 0009-0003-7421-5514]	Envisioned the idea, downloaded and reviewed the articles, and wrote the paper
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