HEALTH INFORMATION SYSTEMS AND DECISION MAKING IN DEVELOPING COUNTRIES: A CASE STUDY OF MALARIA PROGRAM IN LIBERIA

Dissertation Manuscript

Submitted to Unicaf University in Zambia
in partial fulfillment of the requirements
for the degree of

Doctor of Philosophy (PhD) in Public Health

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August 2025

Approval of the Thesis

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Doctor of Philosophy (PhD) in Public Health

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Abstract

HEALTH INFORMATION SYSTEMS AND DECISION MAKING IN DEVELOPING COUNTRIES: A CASE STUDY OF MALARIA PROGRAM IN LIBERIA

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This study centered its research on Health Management Information Systems (HMIS) and decision-making using data from less developed countries in Africa, investigating data demand and use; with the aim of employing a mixed method approach to foster an understanding of the development and operation of the health information system, its management, and its function in decision-making.

The study engaged the staff and data officers using the Health Management Information system (HMIS) and the District Health Information Systems (DHIS2) on a day-to-day routine data collection process as its participants including other Liberia Ministry of Health (MOH) top officers and hierarchy, the malaria program intervention has used the HMIS and DHIS2 as the only consistent routine reporting platform and due to its functionality the malaria disease data is used for this study.

This study aims to develop an understanding in evolution and functionality of HMIS using a mix method approach (qualitative and quantitative), and its role confronting decision-making related to health planning, especially malaria prevention and control in Liberia. With focus on two key

objectives to be achieved, 1) To investigate the difficulties impacting the health management information system in order to produce reliable and high-quality data. And 2) to explore the challenges hindering the systemic decision-making and planning using quality data as related to disease prevention and control in Liberia.

The findings showed that the District Health Information Systems (DHIS2) database has existed for fourteen years and has enabled a unified reporting system for Liberia, this has come as a country's massive achievement but data use and focused capacity building for quality data collection has some challenges.

In conclusion, the study shows it is paramount that sustainable health systems are dependent on effective and strengthened health information systems which are critical to creating a resilient health intervention system and providing a body of knowledge on why HMIS systems and decision-making through data evidence might remain weak. Major obstacles were examined, and recommendations were made on how these gaps can be addressed in Liberia to improve health systems and reduce mortality rates through evidence-based interventions

Declaration

I declare that this thesis has been composed solely by myself and that it has not been submitted, in whole or in part, in any previous application for a degree. Except where stated otherwise by reference or acknowledgment, the work presented is entirely my own.

AI Acknowledgment

I acknowledge that I have not used any AI tools to create, proofread or produce any text or ideas related to any draft or final versions of the thesis.

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Dedication

I wish to dedicate this dissertation first to God almighty and my family, who stood by me and encouraged me all through.

Acknowledgments

Foremost, I would like to express my gratitude to God for seeing me through this journey and, on this occasion, to the Liberia Ministry of health and the malaria control programme. They shared their time and thoughts with me, and without them, the projects would not have been possible.

I would also like to express my deepest thanks to my supervisors, *Dr Charoula Nikolaou* and other UNICAF doctorate staff. Their feedback, patience, encouragement, and immense knowledge were key motivations throughout my PhD. I would like to express my deepest thanks for always encouraging my research, providing insightful comments, and allowing me to grow as a researcher. I am also truly thankful for your dedication to both my personal and academic development without mentioning names for all the tutors in my PhD journey. Thank you for the excellent feedback on this thesis and thank you for believing I can get better.

I express my heartfelt gratitude to *my wife, Patricia Ochai and my kids Roni, Reuel and Ramiah*, whose faithful support and care during these years are appreciated. Your support means the world to me. Next, I would like to thank my dear friend and strength behind this study Dr. Sam Anya and my fellow PhD students for their contributions through our interactions; some deserve special thanks, including my friend Sam Anya, who has greatly supported my academic and personal life.

Last but certainly not least, I would like to thank my family, The Ochais, for all their love and encouragement. My parents, *Bennard* and *Janet Ochai (both late)*, raised me to love learning and inspired me to seek higher education. Thank you, Mom and Dad, for showing me at an early age that the function of education is to teach one to think intensively and think critically.

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List of Abbreviations

CHAI	Clinton Health Access Initiative
DHIS	District Health Information System
EDR	Electronic Medical Records
HMIS	Health Management Information System
HMN	Health Matrics Network
HIS	Health Information System
IT	Information Technology
WHO	World Health Organization
UN	United Nations
MDG	Millenium Development Goals
SDG	Sustainable Development Goals
MOH	Ministry of Health
NDHS	National Demographic Health Survey
HFS	Health Facility Survey
PMI	Presidential Malaria Initiative
PEPFAR	President’s Emergency Plan for AIDS relief
USAID	United State Agency for International Development

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CHAPTER 1: INTRODUCTION

Despite the known benefits of information data for health system strengthening, numerous challenges continue to impede their use in practice.

Data quality concerns are prevalent in low- and middle-income nations, which are the main focus of health information system (HIS) research in recent years, but overall, the worldwide situation of health information systems (HIS) is characterized by major difficulties (Sahay, 2020). As a result, studies conducted in Asia and Africa show that developing countries are the main victims of data problems (Esene, 2015; Krishnan et al, 2010; Salandwa et al, 2025).

Studies have demonstrated further in Africa that Health Information Systems (HIS) development, decision-making and planning in the health systems using data has been the desire to attain robust health care in most less developed countries in Africa (Esene, 2015; Measure, 2018; Mboera, 2021). Examining data demand, data collection and use with the aim of employing a logical trend with epidemiological approaches using a mixed method to foster disease interventions through robust health information, its management, and its function has been a burning priority (Measure, 2018). Hence the desire to attain high-quality data using a structured health information system that addresses health challenges in developing countries has been a massive challenge of the health sector in Africa; developing and strengthening health information systems (HMIS) at the country level to strategically reduce disease burden through planning becomes paramount. (World Health Organization [WHO] report, 2015).

Combating diseases as described by (WHO, 2015) entails good data systems for quality information and intervention planning, HMIS situation in Africa has been a considerable concern to WHO in conquering diseases. This situation has raised some questions on HMIS challenges

concerning situation or draw back as the case maybe that requires immediate and collective intervention; this situation is agreed by studies and report to have made policies, decision-making and intervention in the health sector very difficult to attain in combating diseases because of the absence of quality data for proper planning (Measure, 2019; Esene, 2015; Mboera. 2021).

Since the correct health management information system (HMIS) is critical to strengthening the health system in developing countries, this research study focuses on bridging the gap by examining the hinderances in completeness, use, and quality of HMIS in health system.

In most developing countries, including Africa, social and economic development is argued to being hindered due to/or a lack of information and information flow systems, especially with health systems that include information for decision-making and planning (UN-MDG, 2000; 2015).

The (WHO, 2016; Lippeveld et al, 2018; Koumamba et al, 2021).) in its report has described HMIS in Africa as enormous or a big challenge, making planning and decisions a huge task in health sectors and attaining desired mortality reduction. In insight into current studies on HMIS data and use in African countries, especially achieving data or information that supports the system in combating diseases like the burden of Malaria through effective and reliable policies for disease informed decision making showed difficulties in attaining a data driven response (Mboera et al, 2021; Salangwa et al, 2025).

Studies also agree globally that to reduce this disease burdens countries must focus on gathering information from interventions for decision making on health planning, resource allocation in health interventions, and policy formation for disease control and prevention is essential. Especially considering the limited resources available in Africa as described by (Salangwa et al, 2025; WHO, 2018; 2022).

The health system and health information system in disease implementation.

The Liberia malaria intervention is the focus case study for this study; this is due to malaria alarming rate globally, its robust data collection and storage systems using the DHIS2 platform and HMIS database.

This is crucial for this study to better explain, comprehend, and establish the connection between the processes of health systems and the implementation of health information through systems or record as will be discussed in the cause of this study progress, as it is very vital to state the World Health Organization's global understanding of these topics. Firstly, as defined by (WHO, 2020).

The WHO/OMS report defines the global health system as "a process of organizations that involves individuals and actions primarily aimed at promoting, restoring, or maintaining good health" (WHO/OMS, 2020). The WHO's report further discussed that in other to a good health system with improved processes, six (6) pillars founded on WHO conceptual framework must be focused on for these objectives to be achieved to achieve this objective (WHO, 2020).

- Leadership and governance: This entails a framework of comprehensive health ownership and collaboration within national health policies, outlining the roles and responsibilities of all stakeholders engaged with critical key health interventions and functions (WHO, 2020).

- Health finance: this implies key health financing that has necessary capital to accommodate expenditures financially related to the health sector requirements to curb population diseases creating care and services that delivers health needs to the people (WHO, 2020).

- Health staff: According to (WHO, 2020), this indicates that a health system should possess or necessitates a framework with adequate and skilled personnel in the healthcare service delivery area to maintain effective and significant health outcomes.

- Essential medication and machineries: This refers to efficient health systems that guarantees effective services to the population and requires availability of essential medication and suitable machineries for the purposes of health care (WHO, 2020).

- Service delivery: The most fundamental aspect of an effective health system signifies an organization of health service provision that adequately aligns with and addresses the health requirements of its communities through either a structured or unstructured system (WHO, 2020). And finally.

- Health information and processes: Very importantly is ensuring availability of efficient health information system that is adequately and necessary available for policies making, document planning and decision making (WHO, 2020).

HIS and systems has been categorized as seeing need for a reliable and accurate information system that aids programs in effective planning, monitoring and evaluating implemented interventions or activities delivered and further achieve set objectives as defined in documented health policies (Koumamba et al, 2021).

The evolution of the District Health Information Systems (DHIS2) and Health Information Management Systems (HMIS) in Africa.

It will be very important to describe the Health Management Information Systems (HMIS) as a different interventional approach in data collection from District Health Information System (DHIS2) data storage systems and their relationships, how it was introduced and evolved in Africa to manage diseases. (WHO, 2020; Koumamba et al, 2021). (Koumamba et al, 2021) described Health Management Information Systems and DHIS2 as an open-source data integration software and platform for the collection. Further clarified how the evaluation and distribution of regular health data produced by the Health Information Systems Program (HISP) with assistance from the Department of Computer Science at the University of Oslo in Norway aims to promote complete integration of disease data (Koumamba et al, 2021; WHO, 2020).

The HMIS and DHIS 2 was originally created and built specifically for gathering data at the level of health data source collection in hospitals, primary health sources, and community information systems within health districts (WHO, 2020; Koumamba et al, 2021). Further, due to challenges to effective data collation and analysis from scattered and non-integrated data. The HMIS system was introduced and discussed among key health stakeholders for better integration and a unified reporting system that enables planning and key decision making. (WHO, 2020; Koumamba et al, 2021).

The perspective of the WHO regarding health system and information management has asserted that, “The health information system serves as the foundation for decision-making and encompasses four essential functions: data generation, compilation, analysis and synthesis, and communication and use” (WHO report, June 2008, p. 2).

WHO also believes that to achieve disease reduction, we need an effective health information system (HIS) to support effective decision making as also described by (Mboera et al, 2021) in the Tanzania study on factors influencing HMIS use as this can be enhanced and achieved

through the global approach of health information systems' structure. This system will depend on fundamental data flow processes that include data collection and transmission from the healthcare sector facilities and other pertinent sectors, data examination and oversight that guarantee overall quality, relevance, and promptness (Salangwa et al, 2025; WHO, 2020). This process will further disseminate information about health-related decision-making and quality implementations to the population. (Koumamba et al, 2021; WHO, 2020).

Though, some countries in Africa used the HMN to assess their health information system as ascertained by (WHO, 2008) report. There are still challenges around the health information systems' immediate issues, such as systemic issues that have cost countries poor data collection processes and decision-making (Measures, 2019; Koumamba et al, 2021).

Many researchers, such as (Azubuike & Ehiri, 1999; Koumamba et al, 2021) universally agree that the Health Information system can offer numerous advantages, asserting that when information is precise and prompt, particularly regarding health intervention coverage that has been a pivotal element of public health practice. (Azubuike & Ehiri, 1999). If addressed appropriately, it will result in reduced health issues and allow countries to enhance their capacity to track advancements toward their national goals and objectives (Dehnavieh. et al, 2018). High-quality information through an enhanced data collection process is vital for recognizing the strategic changes needed to fulfill obligations for essential health-related decision-making, as outlined by (WHO, June 2008; Koumamba et al, 2021). This entire concept and process concerning information systems, if properly managed, could yield timely and dependable information as one of the foundations of quality information for effective decision-making throughout all health systems and constructing its frameworks (Koumamba et al, 2021). This becomes crucial for interventions and implementations related to disease within the health system, as demonstrated

HIS in developing countries a case of Africa by (Measure, 2019; Azubuike & Ehiri, 1999; Koumamba et al, 2021).

Statement of the Problem

The enormous challenge in Africa is the need for evidence-based decision making from quality data that promotes the nation's sectorial planning and building, mainly focusing on the health system that leads to access to good health. This is now very critical, and more attention is beginning to be paid in developing countries as mentioned by the SDGs; focusing on Liberia, the need for reliable data and evidence-based information system that reduces mortality in fighting diseases, especially in malaria intervention and control is most essential and needed as demonstrated by the Survey Liberia Demographic Health Survey (LHDS, 2019). The critical factor to planning and access to health as globally recognized is the knowledge and ability to have a clear and organized health data flow system (collect, analyze and interpret) that uses data for informed decision making as recognized in (Measure, 2019).

Likewise, critical decisions that are significant to health access and address existing challenges would require high-quality data for the Liberia health system.

Because the right health information and management system is key to strengthening the health system in country’s health interventions, this research study focuses on bridging the gap through assessing gaps, completeness, use and quality of HMIS in using Liberia health system inform decisions making as a case study. Additionally, choosing the Liberia health system and malaria data is due to its current and efficient data collection practices.

In generating appropriate reliable information that is timely and accurate to health practice, harnessing potentials health information through the system must be engaged. Liberia national

Demographic Health Survey [LDHS], 2010). The (LDHS, 2010) reported malaria-related morbidity and mortality declined for three years consecutively, but that was before the Ebola crisis and after the war. This was an excellent development, but because intervention, data collection and data quality were issues, disease morbidity and mortality might rise.

As a huge gain and in comparison, with the (LDHS, 2019) survey, there has been some huge increase in malaria prevention strategies focusing on Insecticide Treated Nets (ITNs) ownership from 47% in 2009 to 62% in 2016, though ownership of ITNs dropped to 55% as recorded by the (LDHS, 2019). The (LDHS, 2019) further indicated the trends of ITNs household ownership with uses. The use of mosquito nets according to malaria disease intervention and control (LMIS, 2022) is central strategy in malaria prevention, and a core intervention in reducing the morbidity and mortality rate in Liberia (LMIS, 2022). However, even though findings from the (LDHS, 2019) showed an increase in ITNs ownership and a drop in 2019 to 2020 the current year of survey (LDHS, 2019) and (LMIS, 2022). This further points to the direction of data quality, data usage for planning and directing the intervention focus on data collection, demand and use for efficient decision making in the malaria program. (LDHS, 2019; LMIS, 2022).

Also, (LMIS, 2022) noted that the proportion of the household population with access to an ITN increased from 25% in the 2009 LMIS to 42% in the 2016 LMIS and 52% in the (LMIS, 2022). However, the proportion of the household population that slept under an ITN the night prior to the survey was also noted. (LMIS, 2022). There was a rise of 23% in 2022 compared to 2009 LMIS, which shows 39% in the 2016 LMIS, and 44% in 2022 LMIS as reported by (LDHS, 2019; LMIS, 2022, p34) in Liberia.

It is now essential that decisions that will significantly impact health disease control should be in place. However, this will primarily rely on robust and efficient health information systems and their management within nations.

This research believes that developing and strengthening information systems at country or national level will provide high-quality data through health facilities as significant sources of data collection will enable intervention targets to become purposeful and very reliable in reducing disease burdens. This research focuses on the Liberia health information systems and its challenges; it focuses majorly on the Ministry of Health (MoH).

Justifications

It is maintained by experts and academics as previously mentioned that efficient oversight and supervision of health care initiatives will enhance completeness, data precision, and the promptness of data transfer among health facilities (PHCs, hospitals, clinics, and other health facilities) to a central information backup system (Esene, 2015; Peersman et al, 2009; Gimbel, 2011). As argued and agreed by scholars, researchers and project professionals around the globe on effective and efficient use of information from key data (Esene, 2015), and other researchers have claimed that correct information has been a very important component in all health interventions and successes of large-scale interventions on combating health system challenges and have achieved major health improvements through effective planning and decision making from quality data (Peersman et al, 2009; Campbell, 2007; Esene, 2015).

These studies further explained and emphasized validity, relevant and correct information being critical to health decision makers and project managers around the globe if the weaknesses in health systems data and information flow are recognized and addressed in service

provision or planning and actions are taken that will improve disease interventions and service delivery (Akande, 2010). Additionally, these researchers concur that the creation of efficient information systems is an essential prerequisite for enhancement of managerial capabilities and planning within the national health systems (Esene, 2015; AbouZahr & Boerma, 2005; Ofovwe & Ofili, 2005).

The Liberia national Health Policy Plan, further stressed that a fundamental pillar in health delivery and system refer to service delivery locations where primary health information data is gathered, as observed in other African nations. Liberia national Health Policy Plan [NHPP], 2013 – 2018; Esene, 2015). Some relevant gaps as shown by various studies and assessments reviewed emphasized on some challenges around HMIS that lingers till date, these opinions emphasizes that successes of any health system data quality and information flow depends on the health facilities service delivery providers and data entry experts, being capable of gathering and sending timely, complete, and high-quality data consistently to the different levels of the health information systems data flow (these systems transition from the community primary health facility systems through the local government points to regional level and then central level (Esene, 2015).

The National Primary Healthcare Development Agency 2001 and Liberia national Health Policy Plan further identified the weakest link and determinant to be same health facilities service providers' point. The National Primary Healthcare Development Agency [NPHCDA], 2001; NRHPS, 2018 – 2023).

Additionally, the insights and suggestions regarding facility data for the enhancement and application of HMIS will function as a valuable reference to inform further implementation modifications and propose strategies to the ministry of health, which would greatly aid the government's initiatives on healthcare advancement and interventions, disease prevention,

collaboration, and funding to guarantee the availability of essential facilities, equipment, and infrastructure that will cultivate and maintain an efficient healthcare service and system that lowers the mortality rate for the nation (Measure, 2018; Esene, 2015).

Purpose of the Study, Research Aims, and Objectives

The purpose of this study is to develop an understanding in evolution and functionality of the HMIS in less developed countries, and its role confronting decision-making related to health intervention planning, using malaria prevention and control in Liberia as a case study.

The aim of the study employing a mixed method approach is to foster an understanding of the development and operation of the health information system, its management, and its function in decision-making connected to malaria prevention and control in Liberia. Additionally, to understand the factors or reasons behind the HMIS's capacity to produce high-quality malaria-related data. Furthermore, to comprehend how decisions regarding malaria prevention and control are formulated.

Since Liberia is emerging from a destructive war and health crisis (Ebola) for more than 14 years, Liberia's health systems, including services and care for the population, have been disrupted because of these years of conflict and an unorganized health care system (Liberia Implementation plan [LIP], 2009). Reasons why the (Liberia Demographic Health Survey [LDHS], 2019) expressed how Malaria continues to be a prevalent disease in Liberia and is considered one of the major public health challenges encountered in the nation, with the most affected groups being children under the age of 5 and pregnant women (Liberia Malaria Indicator Survey [LMIS], 2022; LDHS, 2019)

The focus was on strengthening national capacity to synthesize, analyze, interpret and use the data in the given country context (Forest et al, 2006). In Liberia, the National Health Policy

and strategy Framework and National Health Plan have carefully and clearly outlined its national goals and priorities to have a recognized evidence-based data and information platform that contributes to the improvement of Liberian population health status through informed interventions (National Health Policy and strategy Framework [NHPSF], 2018 - 2023) and the [National Health Plan (NHP], 2007-2011). The HMIS and its structure within the national health policy is regarded as one of the vital foundational instruments of the health system, which enhances an evidence-based framework through critical quality data to generate significant decisions that will effectively tackle the health condition of the population, identified as a top priority issue (NHPSF, 2018 - 2023).

This research tends to provide current insight on knowledge, data demand and use. This study will also assess the practices and gaps existing in HMIS amongst health care facilities data capture, attitudes of the health care staff in PHC facilities and health services which subsequently offer the basis for efficient planning and decision making (Esene, 2015). The research also aims to explore the advancement of data utilization and subsequent evaluation of training protocols and strategies, to enhance personnel development and execution of HMIS programs in health facilities, particularly health facilities in Liberia as outlined by Esene in his PHC study (Esene, 2015).

The research is centered on comprehending data demand and usage, alongside concerns related to the quality of data for decision-making and the insufficient implementation of the HMIS, despite various modifications it has experienced since its initiation (Esene, 2015). These issues also center on malaria disease intervention and the necessity to address the gaps in health sector frameworks that impact planning concerning the National malaria interventions, particularly the Liberia Strategic Malaria Development Plan. This applies to the comprehension of tackling the challenges and gaps positions to the enhancement of the Health Management Information System

as one of its primary substantive goals (Measure, 2018; Esene, 2015). Insights from this research and suggestions regarding the quality of the HMIS will empower relevant stakeholders to make informed decisions about the enhancement of data related to Liberia's malaria disease interventions and strategies for improving and sustaining the quality of health information. (Esene, 2015). Consequently, this will further improve Liberia's health system's capability to enhance its performance and provide intervention-oriented health services and utilize data accurately and effectively.

As emphasized by (UN-MDG, 2015) to ensuring the availability of accurate health data for health accountability and framework through comprehensive approach towards health data capture and analysis, this will also be addressed as a core focus under the objective 2 of the study to further recommend and support the Liberia Strategic Malaria Development Plan and malaria indicator survey (Liberia MIS, 2022; UN-MDG, 2015). Therefore, this research study is pertinent in its suggestion on skills to assess whether existing data evaluates the relevant goals it aimed to achieve in order to prevent and combat diseases, this is also in response to the (UN-MDG, 2015; Esene, 2015).

Further, the need for appropriate and trustworthy evidence and decisions grounded in evidence to bolster health planning are currently especially essential concerning malaria management. execution strategies (Malaria control implementation plan [MIP], 2009). To attain the evolution and functionality of the HMIS and its role in decision-making as its main goal, the study has engaged two key objectives below.

1. To investigate the difficulties impacting the health management information system functionality in order to produce reliable and high-quality data.

2. To explore the challenges hindering the systemic decision-making and planning using quality data as related to disease prevention and control in Liberia.

Nature and Significance of the Study

This study, in nature, has adopted a case study design using a mixed-method approach and triangulating at some stages were necessary as the study progresses. The study has engaged and collected health facilities data for the research, including regional and central level facilities using techniques that include document review, survey, in-depth interview of key informants, direct participation and direct observation of practices. To answer research questions that affect "how data supports planning in malaria prevention and control?" Qualitative data was collected to respond to such questions, while both quantitative and qualitative data were also engaged to answer research question relating to "the reliability and appropriateness of the malaria HMIS data for malaria control decision-making is?" in the context of this research.

Due to the intricacy of the health system in the nation's health facilities around the 15 counties, the study started with key in-depth interviews at the national level involving ministry staff and such was embarked upon. Then focus group discussions were engaged with mid-level and low-level staff directly involved in the HMIS process. In the case of any information that was missing during the study data collection process, another questionnaire that gathered other information through a larger population sample for triangulation was constructed (Abawi, 2017).

key informant interviews and document reviews were also used to gather information about historical antecedents, evolution, and functionality of HMIS system. In addition to key informants' interviews described above, individuals who formerly occupied senior positions at the MOH were identified and approached for responses as the case may be or as needed.

Following the conversations with key stakeholders across Africa on the importance of HMIS and its significance to this study, it will be very important to also understand how the HMIS has evolved in Africa to support data quality and use (Koumamba et al, 2021). HMIS systems platform transitioned from the HIS and HMIS to a web-based format in 2006, with a national-level adaptation in African nations like Nigeria, Liberia, and South Africa, (Koumamba et al, 2021). Further, moving to Namibia and other countries in the continent (Koumamba et al, 2021). Hence, the introduction of the DHIS initial instance to the DHIS second version, called “version 2” from the earlier DHIS platform, initially termed to be the first country’s version that wasn’t completely integrated, as supported by (Koumamba et al, 2021).

This data and health management systems (HMIS) were intended towards strengthening health data follow from field capture of aggregated data from health programs to a central point of analysis and policy formation that guides disease implementation, though it was later realised through continuous implementation that analysis could be done at the district level to inform community interventions. The application comes in a very user friendly and diverse specific module, that has the "tracker" which can be set up to permit data recording in the most detailed manner achievable and enable automated compilation for further graphs and analysis. OMS. WHO. (2020; Koumamba et al, 2021). This module in its description by (OMS-WHO, 2020; Koumamba et al. (2021) its not just to gather data but even in analysing data and so it described as far from fulfilling merely the function of an electronic patient record EMR but additionally, highly focused on data particular to certain diseases such as Malaria, Tuberculosis and HIV health programs care services (Koumamba et al, 2021). The has made the health management information systems (HMIS) more elaborate with more complex data (Koumamba et al, 2021).

With consideration given to the health management information system software evolution as discussed above, it was also agreed that the implementation of the software must consider the process involved, such as data collation and transfer, analysis and programming at every level of health services and care provision in the health Putting into considerations the health management information system software evolvement as discussed above, it was also agreed that the implementation of the software must consider the process involved such processes of data collation and transfer, analysis and programming at every level of health services and care provision in health system (Koumamba. et al, 2021). Health information and its management in the system was introduced as a very important and major software that should support health sector data and information gathering for health intervention decision-making, implementation plans and key policy formation (OMS-WHO, 2020; Koumamba et al. (2021). This process also supports development of frameworks, epidemiological pattern, its surveillance and thorough assessment of health measures (Koumamba. et al, 2021). For the health systems, its information and management to be worthwhile in its said objectives, it becomes paramount that the development of the health information software be supported by sufficient governance policies as recommended by (OMS-WHO, 2020; Koumamba et al. (2021)

This move will further encourage the integration of all Health Management Information Systems related processes and aspects, including data flow from harmonizing indicators to forms (electronic or paper-based) for consolidated data (data flow) gathering, collation, and transfers to databases that are user-friendly and accepted by users like other electronic medical records and health management information systems (OMS-WHO, 2020; Koumamba et al. (2021)

Data Analysis

For the Quantitative data, the study will engage SPSS and Stata/IC 11.0 to produce real-time result for this research as the SPSS in its application can handle extensive data and perform rigorous analysis. At the same time, qualitative data would engage NVIVO which will be transcribed and coded; the structuration theory will be employed through the application of social theory to enrich the qualitative result to be produced (Anthony, 1984).

These data analyses will be descriptive, and inferential statistics approaches will also be applied for correct inferences of the analysis; this will help the research study find a steady pattern.

Potential significance

The (WHO reports, 1994, 2000, 2015; Measure, 2019; LDHS, 2019) multiple times have emphasized health management and information system in Africa having numerous setbacks due to lack of adequate data gathering and reporting systems, making decision-making and policy formation in health sector very difficult to attain, especially in combating diseases like malaria (LDHS, 2013; 2019). Therefore, a persuasive and functional structure for evaluating health system performance is essential for the functions of governance, government, development agencies, and multilateral institutions.

Hence, the objective to investigate the difficulties impacting the health management information system functionality to produce reliable and high-quality data will be examined. The apparent consequence of this data challenge is the continuing limited availability of high quality in-country data to base contextually relevant decisions that will contribute to planning and improving the health system.

In Liberia health sector, the need for consistent and evidence informed decision-making from quality data becomes critical in the health care service provision and systems, especially in

malaria control (LDHS, 2013; 2019). Looking into these data challenges to further combat subsequent health challenges, the first step will be to develop and strengthen the health system through intentional structures that strengthens management information and system at country level that will provide high-quality data through health facilities as significant sources of data gathering. The second method emphasizes enhancing national capability to gather, analyze, interpret, and utilize the data for decision-making within the specified health context of the country.

In addition, this study in its objective explored the challenges hindering the systemic decision-making and planning using the systems quality data as related to disease prevention and control in Liberia. And in collaboration with already stated challenge of HMIS in Africa that have setbacks due to lack of adequate data gathering and reporting systems, making decision-making and policy formation (Measure, 2019).

This research result will be presented to decision-makers and used to explore or recommend how evidence is perceived and used to a) further strengthen the health information system and b) inform decisions about malaria control that will further reduce mortality rate and improve population health stability.

This study in its design and expectations will generate evidence on why the management of health information systems and decision making based on evidence continues to be weak and how they can be strengthened sustainably in developing countries to improved health systems and reduce mortality rates through evidence-based interventions.

Research objectives

To investigate the difficulties impacting the health management information system functionality in order to produce reliable and high-quality data.

To explore the challenges hindering the systemic decision-making and planning using quality data as related to disease prevention and control in Liberia.

Research Questions and Research Hypotheses

The Research questions are aligned to the objectives, problem and purpose as stated in this study and stated above.

RQ1. How has HMIS developed and evolved in the past five years?

RQ2. How appropriate is the malaria HMIS data for malaria control decision-making?

RQ3. How has the use of HMIS data supported planning in malaria prevention and control?

RQ4. What are the expected determinants of effective HMIS strengthening for malaria control in the country?

Hypotheses

H10. The health management information system is not appropriate for malaria control decision making

H1a. The health management information system is reliable and appropriate for malaria control decision-making.

H10. The health management information system has not been pictured and used correctly.

H1a. The health management information system has been pictured and used correctly.

H10. Decisions on Malaria prevention and control have not been made using valid HMIS data

H1a. Decisions on Malaria prevention and control have been made using valid HMIS data.

CHAPTER 2: LITERATURE

” (Carla AbouZahr et al, 2005). in their article claimed that Nothing exists until it is measured”

Introduction

An introduction to the topic

This study aims to use the case of malaria prevention and control in Liberia to gain a better understanding of the evolution and functionality of the HMIS in less developed nations, as well as its function in addressing decision-making pertaining to health intervention planning using a mixed method research approach to address health development.

Though not much research on HMIS, data use and the health sector in Africa has been conducted recently, However, couple of health management information system and use assessments have been conducted in some part of Africa (as will be discussed in the literature) including Liberia. Such as the Liberia Data Quality Implementation Plan [DQIP], 2022 – 2027). Hence, this study review has mirrored its literature on the most recent literature on health data and a few older literatures that focus specifically on HIS due to lack of current literature on data information and use.

An effective health system and information gathering in general enable developmental growth and networking that support effective planning and key policy formation, reason why this study is focused on “health management information systems and its uses in diseases planning” (Esene, 2015; Carla AbouZahr et al, 2005). Any collection

of components that work together to accomplish a shared goal is, according to the WHO definition, considered a "system." The goal of a health information system is to enhance the administration of healthcare ser vices through the best possible information assistance. We define "information" as a meaningful collection of facts or data. (WHO report, 2015).

Although the meanings of "system" and "information" are readily agreed upon, the term "health information system" is more difficult to define. Initially, health information systems focused on collecting data on diseases "surveillance" and health service results. Although these functions are undoubtedly crucial, we would rather begin with the industry-standard definition of information systems.

The WHO reports of 2000 and 2015 defined systems to be a structure that offer targeted information support to the decision-making process at every level of an institution. Consequently, the main goal of health information systems is not to "to gain information" but rather "to improve action". When applied to the health industry, health information systems may now be defined as a collection of elements and methods designed to produce Information that will help decision-making about healthcare management at every level of the system as was corroborated by Measure report on data demand and use of 2019 (Measure, 2019; WHO report, 2015).

According to the United Nations SDG, social and economic development are being hindered globally and mostly in developing countries due to a lack of information systems, especially health systems, for decision-making and planning. Human development has been one of the most discussed in information and lack of information systems; efforts are being made globally to curb this menace, especially by the United Nations (UN) agencies. (UN-SDG, 2015).

In Africa, Health Information and its System (HIS) has been regarded as a challenging and enormous challenge that affects key decision-making in planning health sector interventions, which is very difficult, especially in combating diseases like Malaria or curtailing the burden (WHO report, 2000, 2017; Mboera et al, 2021). If this burden is to be reduced, then a critical decision on planning, resource allocation, disease control policies, contributions, and prevention is essential, considering the limited resources in Africa.

The United Nations Sustainable Development Goals (SDGs) focus and bid to reduce global diseases, essentially targets reduction of disease burdens and significantly eliminating Malaria though one of the key objectives and as central to SDG 3 (UN-SDG, 2015). This objective tends to ensure healthy lives of the global population and promote well-being for all and regardless of age distribution in population, the UN SDG objective 3 has this ambition in target 3.3 that also emphasized on the SDG ending AIDS, tuberculosis, malaria epidemic by 2030 putting all key strategies in place (UN SDG, 2015). The (WHO report, 2017) also described disease prevention and control challenges in Africa as the most significant burden in the developing and less developed countries that hinder sustained investment in health (WHO report, 2017). The report laid emphasis on malaria, which is claimed to be one of the most critical disease areas in sub-Saharan Africa but unfortunately lacks potential financial resources to combat this disease and generate economic growth (WHO report, 2017), this was reaffirmed through a study on implementing health financing reforms in Africa by (Achoki & Lesogo, 2016).

Further, it clarified that reducing this burden is a global effort requiring decisions on policy, planning, resource allocation, and disease prevention and control management. Consequently, with the restricted resources in developing countries, essential choices based

on evidence data should be made to impact health significantly (UN-SDG, 2015; WHO report, 2017; Achoki & Lesogo, 2016).

The report also claimed that efforts and strategies in place for disease prevention, control and elimination, especially in malaria disease area, contribute to reducing mortality rates and benefits sustainable development in the economy due to promotion of good health (Salangwa et al, 2025; WHO report, 2017). The malaria diseases global and regional trends are reported yearly by the WHO in its reports that are disseminated in all regions and countries, also this yearly report shows the trend in malaria and the countries with huge burden of both emerging and current malaria cases and deaths (Salangwa et al, 2025). According to the reports, the current WHO World malaria reports of 2019 statistics showed that 229 million malaria cases have been reported globally in 2019, there were 409,000 deaths from malaria according to the same report (WHO report, 2019). The report gave population breakdown of these deaths are as follows, sixty seven percent (67%) which is 274,000 were children under five years of age, while Thirty three percent (33%) of the deaths were above Five (5) years of age (WHO malaria report, 2019). This mortality rate from malaria among children under 5 years of age equates to a daily toll of around 750 children under 5 worldwide, particularly in sub-Saharan African countries as worst hit (WHO malaria report, 2019). This report is also demonstrated by Salangwa, et al. and Mboera, et al in their studies of 2021 and 2025 on utilization of data and data performance using HMIS, which described the challenges of data use in Tanzania and Malawi as demonstrated in this study (Salangwa et al, 2025; Mboera et al, 2021). Malaria has become an urgent public health priority, with 70 per cent of all cases from Africa (WHO World malaria reports, 2019).

However, the WHO global malaria report currently reported 94% of malaria cases in Africa (World malaria report, 2023).

With the focus on Liberia's health systems and a specific focus on malaria information, where the entire population is approximately 5.057 5.2 million and if not well attended to could be at risk as reported by the Liberia Population and Housing Census (LPHC) and United Nations Population Division 2019 revision (LPHC, 2022; UNPD, 2019). Malaria has emerged as a major health issue in Liberia (Liberia National Demographic Health Survey [LDHS] report, 2013; 2019). Moreover, the WHO health facility survey indicated that pregnant women and children under five years old are the groups most impacted by the malaria disease (Health Facility Survey [HFS], 2018). Additionally, the (HFS, 2018; LMIS, 2022) stated that malaria still represents the primary cause of illness and death in Liberia's healthcare system, accounting for 34% of all outpatient consultations and 48% of year 2022 reported inpatient cases in Liberia and its malaria program interventions (LMIS, 2022).

Since the correct health management information system becomes essential to data gathering for strengthening health system in countries health and economic development, this research study focuses on bridging the gap by examining the challenges, completeness, data quality and use of HMIS information to interventions and reduction of disease infections in health system (Measure, 2018; LMIS, 2022). During this research, this study will assess the health systems and the pattern of information management, focusing on the malaria disease in the Liberia health system as a case study.

In generating appropriate information that is timely, accurate, and reliable in health practice that supports health systems growth, some accurate, correct and timely information

that is effective and potentially viable must harness from health systems (DQIP, 2022). In Liberia the (LDHS, 2013) reported that malaria-related morbidity and mortality declined for three years consecutively, before the Ebola crisis and after the war. This was an excellent development, but because intervention, data collection and data quality were issues, the disease morbidity and mortality might rise. Further, in comparison with the post Ebola (LDHS, 2019) survey, the report still emphasized a decrease in ITN malaria prevention rate amongst households of 55% in 2019 compared to 62% in 2016. It is now essential that decisions that will have the most significant impact on health disease control should be in place; however, this will depend mainly on sound and effective HMIS in underdeveloped or developing countries.

The research will develop a corridor of understanding between the development and functionality of HMIS and its role in decision making on Liberia's malaria programme and control. Further, to explore factors that could hinder the ability of Liberia health information and management system in producing high-quality malaria-related information. And to fill the gaps in decision-making concerning malaria prevention and control (DQIP, 2022).

To reduce this endemic, it becomes paramount that global efforts are needed to assist developing countries through policies and planning with evidence-based data for crucial decision-making. This indicates that there is a necessity for efficient evidence-based information for to make decision and policy development in the health system is now most important than ever in developing countries, in Liberia's health sector; the need for reliable and evidence-based information in malaria control is most critical to inform policies, especially with the recent breakdown of health systems due to the civil war and hard-hit Ebola virus outbreak (Measure, 2018; LDHS, 2019).

Hence, critical decisions that are very significant and different from the existing approach that would be an effective health system game changer might need to be engaged but would be informed by quality data as presented in the Liberia national demographic health survey (LDHS, 2019).

A common strategy to attain quality process and data in this research is intended to be focused on two comprehensive issues that would have to be addressed, which could make the health system rely on strengthened data and built Health Information Systems.

The initial point will explore methods to enhance the country's ability to gather, analyze, understand, and apply the data within the specific national context (Measure, 2018; Forest et al, 2006). Liberia national health policy and its framework with country's National health plan clearly described these health systems national goals and priorities for Liberia and its disease interventions (Health Framework [HPF], 2007; National Health Plan [NHP], 2007 – 2011). The HMIS is regarded as one of the crucial components of the health system, if not the most significant, and as a result, has been designated as a high priority issue in Liberia's national health plan and its building block (NHP, 2007 – 2011).

To examine these key priorities and strategies that strengthens national capacities, some key health performing indicators will have to be looked at, such as strength of public health human resources especially at the communities of priority health services (NHP, 2007 – 2011). This approach will further aid in identifying the need to prioritize disease challenges and health system gaps, support the formulation of effective policies and frameworks for health and respond to public health emergencies through informed data-based decisions (NHP, 2007 – 2011; LIP, 2009). Further, this would affirm to processes that lead to improved health outcomes becoming a key priority in health system improvement.

Secondly, the health system's proper and consistent use of reliable and evidence date-based decision-making is very paramount to malaria control and its effect on the national health system (LIP, 2009).

The importance of health information systems

Again, as stated by (Carla AbouZahr. *et al*, 2005). That "*In performance… nothing exists until it is measured…."* As referred to the population health systems and planning, only data can ascertain the units of measurement in any health information system, including data management for policy, decision-making and planning (Carla AbouZahr. *et al*, 2005). It was also demonstrated by the (United Nations Development Programme Capacity Development [UNDP] 2009) report which emphasized that good governance of health system requires reliability, also emphasized that successful health and economic development centers around countries have sufficient capacity for planning and interventions. Also, other researchers like (Carla AbouZahr *et al*, 2005) agreed that timely information that results from a system with quality data requires adequate capacity in the system.

Program leaders who make decisions and stakeholders in the health sector must be informed and able to measure if adequate care and services are being delivered to the population, and where resources are being channeled in the health system. (UNDP report, 2009; UN-SDG, 2015*)*. Also, adequate capacity and role HIS in the health system will help strengthen and ensure proper data gathering, support the examination, distribution, and application of well-informed and prompt data by policymakers at every tier of the health system (UNDP report, 2009; Carla AbouZahr. et al, 2005).

With this understanding and significance of data for international health planning and policy formation at large, the UN in setting its targeted sustainable development goals to support health development around the world have set some key plans for a healthier global population (UN-SDG, 2015). These plans focus their attentions on capacity development and data or information systems strengthening, hence achieving these UN-SDG goals then requires some quality and reliable data (UN-SDG, 2015). This whole holistic approach will require a well-functioning health information system that produces quality data that further informs key stakeholders and policy makers for planning, making informed decisions that improve important aspects of global health system (UN-SDG, 2015; UNDP report, 2009).

This will enable countries and implementers to understand and measure scales or patterns of disease trends and further make some relevant policy changes, if need be, to health priorities through a data-informed decision (UN-SDG, 2015; UNDP report, 2009). Additionally, choices regarding the distribution of resources for optimal and effective outcomes become critical and well organized. (UN-SDG, 2015; UNDP report, 2009). However, going by world health organization in response to attaining these UN-SDG goals, the body emphasized that for these approaches to achieve these results it will require a massive investment in capacity to Africa's robust health information systems (WHO report, 2015).

Effective and high-quality data management is essential for enhancing the efficiency of healthcare services, as suggested by the (WHO report, 2000; WHO report, 2015) and further argued by (Lippeveld et al. 2018) in the study HMIS and health services. The imperative to achieve more with fewer resources is particularly critical due to the growing

demands in the health sector, which is experiencing stagnant or diminishing resources, as outlined in the Design and implementation of health information systems article by (Achoki & Lesogo, 2016). Theoretical effectiveness, also known as efficacy, is demonstrated to be significantly reduced when interventions are administered by poorly managed health services (Achoki & Lesogo, 2016).

In another turn of events on programming according to the WHO, for instance, failures to follow up with children under five (5) who do not attend for booster shots, improper use of malaria safety nets for pregnant mothers and children, incorrect age estimation, cold chain breakdowns, and other such issues can reduce the effectiveness of disease control. This report in 2000 and 2015 has re-emphasized that health systems face the challenge of managing service delivery as efficiently as possible while minimizing effectiveness losses. This can only be accomplished with high-quality health information and an efficient health data management system and adequate financing (Achoki & Lesogo, 2016).

For a long time, the World Health Organization and (UN-SDG, 2015) have recognized the importance of health information systems in achieving health for all by the year 2030 (WHO, 2015). There was a WHO world health assembly meeting that was held in 2025, which took place in Geneva and made it plain that HMIS are one of the six essential components. A data collecting system designed especially to aid in planning, management, and decision-making in healthcare facilities, HMIS is crucial for strengthening the health system (Salangwa et al, 2025). The importance of health service data in patient management, facility management, illness monitoring, and keeping an eye on how services are provided, and resources are used. (Achoki & Lesogo, 2016).

These data are essential for nations as they work to assess the efficacy of their healthcare systems and, as a result, achieve Universal Health Coverage (UHC) and the Sustainable Development Goals. In order to guarantee that services are provided in accordance with standards, the WHO emphasized the importance of having well-designed routine information systems (WHO report, 2015; Achoki & Lesogo, 2016).

(Salangwa et al, 2025; Esene, 2015) also stressed that in order for information to have the greatest impact on management, decision-makers must utilize data and high-quality information at every stage of the management loop. The focus of this study is on an example that shows how major data use helps decision-making in policy changes and implementation, even though there was no clear direction on how the data use has helped to develop intervention frameworks from the examples given. Though this research in its focus objectives and hypothesis tends to redirect data use that points at conducting situational analysis, establishing priorities, or carrying out a disease program activity in accordance with data or a data-driven strategy. In accordance with this study objectives, the (Salangwa et al, 2025) study also stressed that information is essential at every level of health service administration, from the periphery to the center. This report emphasized that it is essential for the administration of patients/clients, health units, and the planning and management of the health system (Salangwa et al, 2025). This implies that information should be used in decision-making by policymakers and managers as well as by healthcare practitioners, such as doctors, health technicians, and community health professionals (Qazi & Alli, 2009). Without this, it might be hard to rationalize the high opportunity expenses associated with establishing and maintaining health information systems (Qazi & Alli, 2009; Achoki & Lesogo, 2016).

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In another dimension to data use using mobile to enhance information, the article Transforming the Health Information System using Mobile by (Rosewell et al, 2021) discussed how to use mobile and geographic information technologies that accurately use data in Papua New Guinea. The study stated that changing the manner information is collected, processed, and utilized for decision-making suggests a change in how an organization function (Rosewell et al, 2021). (Rosewell et al. 2021) and the (WHO report, 2000 & 2015) have also noted in their article on health information systems in Papua New Guinea that in order to improve health systems, data has to be used as the entry point for enhancing management skills in the healthcare system in order for the health information system to be developed (Rosewell et al, 2021). In a similar vein, this study hypothesis predicted the development of well-organized routine information systems that are closely tailored to the informational requirements of health care providers. The (WHO report, 2000; 2015) reports stated that the district, health center, and community levels have the potential to contribute to the general enhancement of health service management. However, this is why this study of HMIS and use in its objectives tends to examine the reasons behind lack of quality data and data use for policy and planning using the hypothesis of “How the use of HMIS data has supported planning in malaria prevention and control?”

HMIS Knowledge and practice among healthcare personnel in facilities

(Esene, 2015; Carla AbouZahr et al, 2005) in their studies of PHCs data and HMIS knowledge and practice and in furtherance understanding with this study of HMIS and data use as a focus. Agreed that an effective health system and information gathering in general

enable developmental growth and networking that support effective planning and key policy formation (Esene, 2015; Carla AbouZahr et al, 2005). Further, efficient information system could also inform effective data quality that transcends to achievable interventions and outcomes within the various units of the health system as indicated by Carla AbouZahr et. al, 2005). Furthermore, this study emphasized prompt delivery of adequate health services producing quality reports of clinical activities that include patients and clinicians' records and information allowing decisions regarding intervention processes to be distributed to health facilities and workers in a timely and effective manner (Esene, 2015; Carla AbouZahr et al, 2005). However, the major contention of this study on HMIS and use in developing countries spans beyond prompt delivery of health systems but in the use of HMIS data to support planning in prevention and control? Hence, supporting the right and correct epidemiology and disease control that emanated through quality data and planning information as against just prompt services.

Data-driven and evidence-supported decision making for planning could be very crucial for strategizing and effectively utilizing limited financial and economic resources, especially in efforts to tackle diseases in developing or underdeveloped nations as this study of HMIS tend to achieve (Esene, 2015; Measure, 2018).

This study also reviewed some studies and projects that have laid emphasis on HMIS and data systems in most countries like the Saharan Africa with arguments that information from data for planning are inefficient, and it is also assumed that these challenges could occur due to unreliability of data resulting from underreporting and or staff inexperience due to insufficient knowledge and understanding of existing HMIS system with its uses (Evans & Stansfield**,** 2003; Esene, 2015; Measure, 2018). This study also affirms the over-reporting

or under-reporting of data gathered from various sources of health facilities, including irregular modes of data collection and transfers, which are some other challenges to unreliable data for planning. cited by (Evans & Stansfield**,** 2003; Esene, 2015). Again, most articles and books on data or HMIS are not particular about data use but data collection for use.

In continuation this is the same approach used in a 2003 data use reflective review conducted in Palestine by (Mourad et al, 2003) on the implementation of data collection and gathering involving HMIS flow from PHCs and other health centres, the study showed that there were gaps in achieving the desired quality of data intended (Mourad et al, 2003). This was due to data not collected in the appropriate and documented manner including data transcription, it also demonstrated how inadequate understanding of data movement from the main sources and the application of various data and health information platforms that include HMIS tools are processed inadequately (Mourad et al, 2003). (Mourad et al, 2003) also emphasized that this lapse has led to achieving inadequate health data for planning and neglect of key indicators that would have enhanced data use. Further, the findings showed that the existing Health Information Systems and other information systems platforms that include data gathering tools need to be standardized in their operations at community and health centres, local government, regional and national levels, considering concerns around inappropriate use of the HMIS tools (Mourad et al, 2003; Esene, 2015).

In comparison, this finding is from (Esene, 2015) was also in agreement with similar study conducted in Pakistan by (Qazi & Alli, 2009) on “utilizing qualitative techniques” (an in-depth interviews approach) to explore the perceptions of thirty health managers regarding HMIS, this research also engaged primary health and its services in similar settings within

their health organizational structure (Esene, 2015; Qazi & Alli, 2009). In the findings, the respondents who were facility staff expressed concerns about some challenges around understanding data collection procedures and scarcity of data collection tools, computers and internet systems to collect, collate and transfer data. Other challenges mentioned were skilled personnels knowledge on data collection and those that understand the HMIS processes as recorded by both studies (Esene, 2015; Qazi & Alli (2009).

Some other respondents mentioned that as a result of unskilled data expert, the facility staff has dubbed the Health Management Information Systems unit as a “typing Centre” (Qazi & Alli, 2009). Furthermore, the research asserted that because of a shortage of qualified personnel, the employees at the HMIS desk are the same individuals who were previously assigned tasks not related to HMIS, such as managing other diseases and typing both official and unofficial correspondence for the health facilities (Esene, 2015). For these reasons among others, the respondents additionally clarified that the entry of data into the HMIS registers was either assigned to volunteer health workers or other community health workers attached to facilities and unfortunately with little or no knowledge of the Health Management Information systems processes (Esene, 2015; Qazi & Alli, 2009). As respondents clearly stated in the study report that the Health Management Information Systems unit is often referred to as “dormant end job" in the past (Esene, 2015). This research in assessing the Liberia malaria health management information systems will tend to further investigate some key issues related to understanding and management functions of the HMIS (Qazi & Alli, 2009).

This Pakistan study by (Qazi & Alli, 2009), however went a little further to explore some likely causes that could allow the low-level knowledge of HMIS and considered some

other situations that could be likely to occur. These studies have assumed that a quantitative aspect examination will show the actual proportions of knowledge level that could tend to support the research towards generalization of study findings to the general population (Esene, 2015).

(Mourad et al, 2003; Qazi & Alli, 2009) studies done in Palestine were termed to be a retrospective review and recommendations have been previously implemented on the HMIS processes that produced some key content analysis of current HMIS, though these studies also claimed that other recommendations from the findings is being carried to further strengthen HIS data and its systems management within the nation’s health systems are documented by other researchers as well (Esene, 2015; Mourad et al, 2003) and Qazi and Alli (2009). Nevertheless, with an emphasis on evaluating Liberia's malaria health information study and its comparisons to the data experiences of other countries to gain a better understanding of Health Data Management and Information utilization, these studies are cited in this literature for enhanced comprehension. However, the studies conducted in Pakistan included a thorough strengths, weaknesses, opportunities, and threats (SWOT) analysis of the health systems concerning data usage accordingly. Although these findings may not be broadly applicable due to specific gaps like limited or unavailable sample sizes and selection criteria of respondents that were employed and not documented, it has illuminated issues around the awareness and utilization of HMIS in nations facing difficulties with data and information usage (Esene, 2015; Mourad et al, 2003; Qazi and Alli 2009).

Data and Health Information Management Systems (HMIS)

The Measure Evaluation 2014 assessment of Liberia's health information and systems management highlighted the necessity for possessing dependable and prompt health information, which is identified as one of the essential bases for establishing an efficient health service management and public health initiatives in disease interventions (Measure, 2014; Measure, 2018). This evaluation of the routine health information system conducted in Liberia's health facilities was also characterized as a significant tool for recognizing deficiencies in data gathering and distribution within the health system management (Measure, 2014). This method aims to further tackle challenges related to data in order to sustain and enhance performance across various diseases (Measure, 2014). In light of the vital function of Health Information in disease intervention concerning health systems and the potential roles that could be fulfilled in the successful execution of Liberia's national health policy, this has led the Liberia Ministry of Health and Social Welfare (MOHSW) to prioritize the reconstruction of the HMIS in 2014, which is indeed being accomplished with a reporting rate exceeding 90% in 2018 (Measure, 2018).

The Measure evaluation assessment carried out in 2014, made very direct emphasis on the baseline assessment of HMIS performance conducted in April 2012 using the PRISM frameworks and tools (Measure, 2014). This assessment and evaluation were conducted by Liberia MOHSW with technical support from Liberia Rebuilding Basic Health (RBHS) funded by PEPFAR partners in Liberia (RBHS, 2008; Measure, 2014). The assessment and evaluation carried out by Measure and RBHS reported that quality of data at the facilities and country at large had an average of fifty two percent (52%) while data use being the core for decision-making at as at the time of the evaluation was judged to be very poor (38%)

(RBHS, 2008; Measure, 2014). Therefore, the recommendation from this report from the evaluation was used to further inform adjustment and development of major policies for interventions that strengthens the HMIS in Liberia (Measure, 2014)**.**

This assessment report and recommendation was further forwarded to support the ten years (10) years National Health Policy and Plan; this policy has assigned significant importance to the advancement of a decentralized data system and HMIS in Liberia as a fundamental component of the national health system (RBHS, 2008; Measure, 2014). This Rebuilding Basic Health Services support initiative was supported by the United States Agency USAID for health systems strengthening and data reliability (RBHS, 2008; Measure, 2014). Some statistics and findings from the assessment are outlined below, the 2014 findings were engaged because of the period of research selected.

Health Facility Management Information System Assessment

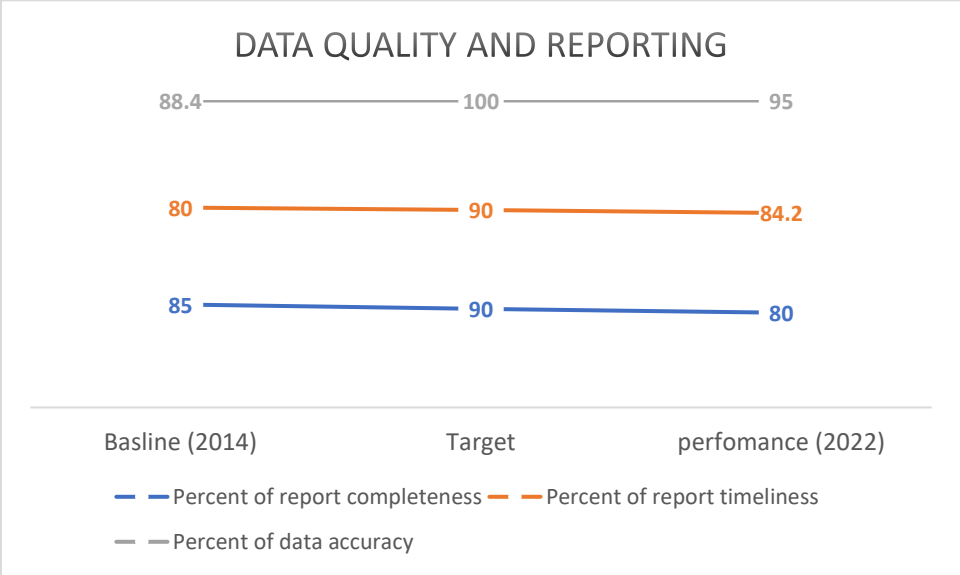
The study also tends to focus on health facilities assessments to further ascertain and recommend any findings on issues and gaps affecting data flow, hence, the facility assessment in this study focused on what could be the fundamental causes regarding data readiness, quality of data, and data utilization at health facilities, district, and county levels Liberia (Data Quality Improvement Plan [DQIP], 2022 -2027). This study through the desk review showed a data evaluation practice and process as assessed by the DQIP team, which was conducted in 243 HFs out of the existing 923 HFs Liberia MOH (DQIP, 2022 -2027). The assessment was conducted engaging a combined methods research strategy of qualitative and quantitative interviews at healthcare facilities respectively, using key Informants' Interviews (KII), In-depth Interviews (IDI) and standardized questionnaire

Liberia MOH (DQIP, 2022 -2027). The facility assessment took a structure of process verification engaging key indicator principles for agreed definite reporting periods that spanned between April to June 2020 putting into consideration the high and low malaria incidence periods, most importantly was the evaluation of completeness and timeliness of data flow from reporting periods and required data collection Liberia MOH (DQIP, 2022 -2027).

These evaluation procedures aim to evaluate how thoroughly the data gathered or information in the original documents (the HMIS tools) from health facilities or service delivery points in the communities had been correctly assembled and recorded in the reports to the subsequent reporting level in the data flow channels. (district, county and central MOH) Liberia MOH (DQIP, 2022 -2027).

The information from source documents (like forms, registers, and summary sheets) was contrasted with data recorded through HMIS and other platforms on the District Health Information System (DHIS2) to confirm or authenticate the figures reported from the source documents, as part of a data quality assurance initiative Liberia MOH (DQIP, 2022 -2027). The health facility evaluation also gathered details on the completeness of reporting, which encompassed data from the three selected consecutive months (April to June 2020) that were finalized for collection and analysis using standardized data collection instruments (both electronic and paper formats were utilized) Liberia MOH (DQIP, 2022 -2027). These results as retrieved and documented were tested in comparison with findings from desk review component of the Data Quality Report (DQR) developed in 2020, this was to assess the processes used to find the fundamental causes on data availability, quality and data use at

health facilities Liberia MOH (DQIP, 2022 -2027; Data Quality Report [DQR], 2020). Summary of the MOHDQIP assessment results is displayed below.



This graph shows that reporting using the HMIS in Liberia health system kept improving over the years with completeness, timeliness and accuracy taken from 2014 as baseline and 2022 study year Liberia MOH (DQIP, 2022 -2027; DQR, 2020). An 80% and above records shows the HMIS usage has been good as regards data collection and entry, this further shows the contribution of HMIS to the health systems Liberia MOH (DQIP, 2022 -2027; DQR, 2020). Further, the questionnaire assessment indices used in this evaluation process includes how data were gathered and recorded in practices, reporting flow practices, health worker knowledge of the system, health worker motivation at facility data entry, staff capacity building and training, engagement and usage of target assessments, and total data utilization indicators were all engaged for the process Liberia MOH Liberia MOH (DQIP, 2022 -2027; DQR, 2020). Triangulating the data gathered from the field review alongside

the desk review was employed to validate findings in order to create a solid basis for the development of the DQIP by the Liberia MOH (DQIP, 2022 -2027; DQR, 2020).

Further this assessment in its review, reveals that more than seventy five percent (75%) of the health management information system designated human resource were high school graduates as against the initial expectations of schooled professionals, such as higher institution graduates Liberia MOH (DQIP, 2022 -2027). Additionally, the report indicated that the majority of health facilities lack full-time dedicated personnel for health management information systems (DQIP, 2022 -2027). Despite the absence of explicit definitions or distinctions regarding the qualifications of health management information personnel at all levels, the report further asserted that none of the employees have received training in health informatics, statistics, or system development and programming (GIS, etc.) (DQIP, 2022 -2027). However, there was no documentation that demonstrated the necessity of GIS systems programming for health information systems qualifications.

Currently, the report showed a very high attrition rate across at the counties, districts and community facilities, particularly in the counties and districts (DQIP, 2022 -2027). These shortages according to the report is because of High differences in pay at national and county levels, along with inadequate motivation and a lack of retention strategy, were noted. (DQIP, 2022 -2027). Assessing the health facilities and according to the health information system assessment, the report also claimed that Liberia health systems has only a limited health facilities with access to power supply and internet connectivity (DQIP, 2022 -2027).

Examining the infrastructure for storing patient records, it was obvious that a minimum of 51. 9% of health facilities lacked enough shelves, tables, and boxes (DQIP, 2022 -2027). Additionally, it was noted that another 53. 6% of health facilities' medical

record rooms were reported to have insufficient space to distinguish between patient records, patient waiting areas, and outpatient rooms. due to lack of adequate space (DQIP, 2022 - 2027).

The health information system assessment report also revealed that some tools like the patients' chart of the health facilities were out of stock since 2016, which is anticipated to serve as a resource for regular health data. (DQIP, 2022 -2027). These deficiencies are further exacerbated by supplementary results from the same DQIP evaluation indicating 70. 4% of health facilities missing computer/tablet/internet. (DQIP, 2022 -2027).

The health facility assessment was a disease comprehensive facility evaluation and did not only have its focus on malaria disease, even though malaria has more health facility spread but all diseases use same health facilities except some disease specific sentinel interventions. Hence, the assessment focused on other health delivery services like prenatal care, childbirths, vaccinations, ART, tuberculosis, and malaria (DQIP, 2022 -2027; DQR, 2020). Again, the evaluation shows that nearly every health facility had source data exceeding 95% except for the TB source data, which stood at 69%. Similarly, the report stated that the completeness of facility reporting across these services was approximately 95% and higher, once more with the exception of TB and bearing in mind that there are no malaria specific staff at facilities (DQIP, 2022 -2027; DQR, 2020). Further evaluations from the assessment observation indicated that 81% of facilities feature assigned personnel to gather, document data, and compile reports (DQIP, 2022 -2027; DQR, 2020).

However, the report still emphasized the fact that there is no mechanism established to gather both unstructured and semi-structured data and information (that encompasses data, documents, and research), among other elements (DQIP, 2022 -2027; DQR, 2020).

Summary of the HMIS assessment Results

Table 1

Health Management Information System Performance in Liberia

HMIS performance indicator. Measure. (2014).	Facilities		Districts	
	2012	2014	2012	2014
PERFORMANCE OF RHIS (***Measure, 2014).***				
Quality of data (***Measure, 2014).***				
Overall accuracy	54%	84%	78%	88%
Data completeness in facility monthly reports	52%	79%		
Completeness of monthly reports at county level			91%	98%
Timeliness of reports of health facilities at county level			74%	88%
Use of information	38%	58%		75%
PROCESS (***Measure, 2014).***				
HMIS procedure manual		62%		
Verification of Data quality	63%	79%		
Filling out of reports in full	72%	81%		
Sending of reports before the deadline	85%	87%		
Feedback to health facilities	20%	49%		50%
Data analysis (***Measure, 2014).***				
Presence of performance targets	33%	35%		
Presence of performance monitoring plan	15%	33%		100%
Performing at least two types of data analysis	15%	39%		100%
Display of data	45%	68%		54%
Supervision (***Measure, 2014).***				
Effective supervision	45%	73%		
Data quality control	82%	97%		
Feedback after supervision	22%	89%		
DETERMINANTS OF HMIS PERFORMANCE (***Measure, 2014).***				
Technical factors (***Measure, 2014).***				
Simplicity of the reporting forms		58%		80%
Simplicity of the software package				100%
Organizational factors (***Measure, 2014).***				
Governance Documentation			75%	80%
Planning documentation			44%	69%
Financial documentation on the RHIS			33%	50%
Training Schedule			0%	75%
Supervision schedule			80%	100%
Promotion of information culture			48%	58%
Trained personnel in charge of the HMIS				
Behavioural factors (***Measure, 2014).***				

Awareness of the rational for HMIS	28%	43%	54%	59%
Knowledge of data quality checking methods	10%	33%	29%	59%
Problem solving skills	8%	24%	27%	61%
Skills observed in performing HMIS task	9%	22%	45%	49%
Self confidence declared in performing HMIS task	51%	68%	71%	80%
Motivations for carrying out HMIS tasks	62%	66%	60%	65%

Note; As curled from the "*Performance of Routine Health Information System Management in Liberia PRISM Assessment*" (Measure, 2014).

Data collection

Within the Liberia healthcare sector and the Malaria control program, malaria source information is produced from recorded or entered data at community and facility levels, data could be either structured or unstructured or both but entered into the provided HMIS tools (DQR, 2020; Measure, 2018). Looking at data structured aspect, data are collected and classified into significance levels that is used as a guide to informed decision making at various levels of healthcare services (Measure, 2014; Iyamu & Mgudlwa, 2018). This was necessary because not all data collected are considered as same key performance indicator level, some data engaged are more relevant to intervention decisions and important to track than others, such recognized data determine mortality and morbidity in interventions and programming in disease preventions as agreed with the argument of (Iyamu and Mgudlwa, 2018; Measure, 2018). This data collection process explains national data flow structures for useful program planning information, then advocates its value in utilizing its potential from both technological and human resources (Iyamu and Mgudlwa, 2018; Measure, 2018). Harnessing of health data and its capabilities in such a study is guided essentially by factors such as availability of facilities, availability of crucial and experienced staffing,

interpretation of guidelines, and an understanding of the data relative to demand and use (MEASURE, 2019; DQIP, 2022 -2027; DQR, 2020).

In assessing Health Information systems and structures for decision-making in Liberia, using malaria control programs and interventions, this study relies on specific strategies between the health structure and information use (Data). They count on and influence each other toward healthcare systems building (Luthuli and Kalusopa, 2018).

In inference, it is thus essential that enhancing health information systems is vital to building a more robust and sustainable health system. Hence, the Liberia health information system study result will tend to promptly provide critical outcomes on the quality of data and how necessary it and important it becomes for health systems response to interventions and needs properly and promptly. Particularly in public health emergencies, an example is Ebola outbreak in Liberia.

This review is designed to explore the theoretical reasoning behind data management and use to address Health information flow and challenges, its importance to health interventions/control and how it relates to functional health systems in Africa (especially Liberia Malaria interventions), and further gain knowledge of the phenomenon through existing literature (MEASURE, 2019). The research will draw some fundamental understanding and findings of health system data management from a desk review of existing documents and articles globally with a key focus on Africa. This study will also help in examining the relationship between Health Information System (HIS), decision-making and planning in developing countries. Significantly, data affects planning and ability to use the strengthened health management information to generate quality program information to

determine intervention, control, transformation and performance from key data outcomes and results (MEASURE, 2019).

HMIS And Challenges in Developing Countries

As referred to earlier, not much research on HMIS, data use and the health sector in Africa have been conducted recently, but like discusses, a couple of health management information system and use assessments have been conducted in some part of Africa as delved into below. Again, this study review in continuation has mirrored its literature on the most recent literature on health data and a few older literatures that focus specifically on HIS due to lack of current literatures on data information and use.

Pakistan in some years now have been conducting some key studies in exploring ways to enhance its Health Management Information systems among developing countries, reason why Pakistan is being used as a key literature for this research. In another study conducted by (Mehmood et al, 2011) in Pakistan, with the aim to assessing and gaining knowledge of data use structure and HMIS practices during interventions among health personnel and facility officers who are responsible of HMIS but this time with focus on Basic Health Units of Tehsil Taxila a community in one of Pakistan regions (Mehmood et al, 2011), Esene, 2015). Further, this community setting is different or away from normal Primary Health Care as compared to earlier literature by (Esene, 2015; Mehmood et al, 2011). Study findings showed that at the facilities where it was recorded that visits to the facilities and cases of diseases were supervised or manned by medical officers-in-charge, 68% of facility HMIS tools and forms were filled during clinical consultations at the outpatient department (OPD) and recorded in registers. While 32% of such malaria cases are recorded where they

are manned or supervised by other health staff such as medical doctors, nurses, volunteers and community field workers or community health workers who are responsible for filling the OPD register and HMIS tools (Esene, 2015; Mehmood et al, 2011).

The study further analyzed monthly facility report and recorded that medical officers were responsible for the collation and transmission or report in sixty four percent (64%) of facilities, while in thirty six percent (36%) of facilities the OPD data were handled by dispensers and medical technicians who prepare the monthly facility reports. Mehmood *et al*. (2011). An inquiry regarding satisfaction monthly report formats usability and flexibility, ninety six percent (96%) of the instances were content with the format while only 4% were not at ease with the report format. due to its complexity as claimed this is same as described in a study on PHC conducted in Nigeria (Mehmood et al, 2011; Esene, 2015; Bawa et al, 2003; Bawa & Umar, 2009).

For data use and decision making, the study showed that eighty four percent (84%) of facilities at Tehsil Taxila in Pakistan were conducting self-evaluation with documented data and examination at the lower facility level to enhance their healthcare service effectiveness and this same percentage of facilities used this data in decision making at community level (Mehmood et al, 2011; Esene, 2015). Overall assessment on facility data and uses of the HMIS tools, it was shown that in the sixty eight percent (68%) of cases entered in the registers at the facility, health staffs did not find any difficulty during data entry using HMIS instruments (Mehmood et al, 2011; Esene, 2015). Though, the study claimed that 32% of cases registered had issues being registered by staff as a result of having some difficulties in filling in forms (Mehmood et al, 2011; Esene, 2015). This research study

was a relatively small study compared to other studies earlier mentioned and a sample of fundamental and essential health units conducted within a community inside a ward (Tehsil) (Mehmood et al, 2011; Esene, 2015). Because this research is relatively small and skewed to a study area and smaller health units (Mehmood et al, 2011), the findings may become a little difficult or biased to generalization to the health information structure and management in Pakistan (Mehmood et al, 2011). However, this HMIS assessment study of Liberia Malaria HMIS data use tends to gain knowledge of HMIS practice, staff knowledge and attitude, and decision making at community levels.

In 2010, another study on health workers reporting was conducted in Pakistan that aimed at examining the precision of reports collected and transferred by health workers using lady health workers (LHW) a replica of Community Health Workers (CHWs) in Pakistan (Mehmood et al, 2010; Esene, 2015). This report is a key step in data collection and data flow for quality reporting in health data flow structure and protocols, engaging a selected forty (40) LHWs for the research as a sample of which eighty percent (80%) had sizeable knowledge about their job description as it boils on data collection, recording and reporting health information. Mehmood *et al.* (2010). Further, eighty percent (80%) of this sample had informed knowledge and good capacity for data flow systems including knowledge of data use (Mehmood et al, 2010; Esene, 2015). Fifteen percent (15%) according to the study report have a satisfactory knowledge of the HMIS structure and management, while Five percent (5%) from study report had low knowledge as regards data collection processes, recording and reporting using the Health Management Information Systems tools (Mehmood et al, 2010). The study report further emphasized low reporting rate cases as regards current

maternal deaths and low babies' weight after birth due to malnutrition and other factors Mehmood et al, 2011; Esene, 2015). This research has recommended an improved data entry and management system capacity to avoid under reporting that is due to insufficient comprehension of HMIS tools, as a result of the application of health management information systems tools and data recorded stood at 12.5% and 10% of cases respectively but other health diseases were around eighty percent (80%) (Mehmood et al, 2010).

This Pakistan 2010 study was qualitative research that used only in-depth interview as a method, the participants of the study were chosen using a purposive sampling method from healthcare facilities across all districts of the region (Mehmood et al, 2011; Esene, 2015). Being a solely qualitative approach, I think the number of respondents may be limited and not be adequate to make a decisive generalization for the Pakistani health systems. And of course, the majority of the respondents being a purposive sample technique may be largely opinionated negatively or positively and being dissatisfied or satisfied with the HMIS structure or system, giving room to making this research findings relatively skewed or growing bias responses to the study (Mehmood et al, 2011; Esene, 2015). On the other hand, engaging in another quantitative study to further triangulate these responses and measure actual knowledge would have been more objective in this study and to aid some form of key recommendations from findings (Esene, 2016).

However, this studies in Pakistan using a cross-sectional technique observed some important findings in which HMIS data entry and usage was reported to have a high knowledge rate of sixty eight percent (68%) and eighty percent (80%) respectively. Mehmood *et al.* (2010). Though not leaving aside that the assumption of high knowledge

level from the cross-sectional report could be related to some reasons around how these investigations were conducted among a defined cohort or group of particular health workers, who are specifically trained in data gathering and HMIS processes and protocols (Esene, 2016; Bawa et al. (2003) and Bawa and Umar. (2009). The comparatively small number (40 LHWs) in the 2010 study might also account for the good practice, relatively elevated knowledge level and positive attitude with the Health Management Information Systems (Esene, 2016; Bawa et al, 2003; Bawa & Umar, 2009). Citing another survey on HIS systems and data researched by (Bodavala, 2012), this assessment evaluated the need for computerized databases in HMIS data collection and transfers by health facility workers at community bearing in mind or holding to the fact that paper-based health management information systems approach has a lot of gaps in data transfer as re-cited by Esene in the study of PHC in Nigeria (Bodavala, 2012; Esene, 2015). In its findings, the study revealed that fifty percent (50%) to seventy percent (70%) of the district statistical officers comprises of some untrained records officers promoted from clerical cadres for HMIS use (Bodavala, 2012; Esene, 2015). The district officers were very much exposed to the paper systems of the health management information systems, while the state level officers who just collect and collate data in the flow were less exposed and knowledgeable on HMIS usage because the whole focus was on the districts as the source of data. (Esene, 2015). The research reported that at state or regional level, data is collated, recorded, and transferred to the state level just to collate for upward transfers but these officers also did not possess the computer skills necessary to assist in directing the data flow and analysis efforts at the regional level due to a lack of capacity (Bodavala, 2012; Esene, 2015; Bawa and Umar, 2009).

Nevertheless, this study along with other related studies indicated that the primary user and provider of information was the Primary Health Care centre itself, yet typically medical officers (responsible for the PHC) displayed little enthusiasm for verifying the data due to a lack of incentives and, of course, it is becoming too much work on top of their daily responsibilities (Bodavala, 2012; Esene, 2015; Bawa and Umar, 2009). Consequently, these issues will impact data entry, collection processes, assessing data quality, and data utilization (Measure, 2018).

In realization from the PHC study (Bodavala, 2012; Bawa et al, 2003), it reveals that two thirds, which is sixty-six (66%) of the health coordinators and officers in charge were claimed to have difficulties in understanding or have not been trained on use of HMIS registers, forms and health information tools related to the health information data (Esene, 2015; Bawa et al. 2003). Taking into account the second layer of information users, which includes supervisors (senior medical officers in charge) who were meant to oversee and direct the functions and responsibilities of the auxiliary nurses and midwives (ANMs) in gathering and transmitting data at the facilities, as also mentioned by (Esene, 2015), these studies indicated that senior coordinators and medical officers responsible for facilities exhibited a feeling of apathy and limited understanding regarding data. that could result from lack of sensitization or capacity building (Esene, 2015; Bawa et al, 2003). These studies had same findings with another study on PHC and health workers understanding of HMIS conducted in rural India in (Krishnan et al, 2010), though was a very small study that engaged in-depth interviews that carried out an investigation on coordinators and facility managers, medical officers and facility health workers (respondents was a small sample of 26). This

research evaluated HMIS knowledge and effectiveness of using computer based HMIS in data collection, collation and retrieval in the health system. (Esene, 2015; Krishnan et al, 2010).

These studies showed that some form of knowledge gaps and low understanding of HMIS processes exist in handling computerized health management. Information data and entry system, it was reported that workers spent more hours that is like double the duration required to refresh their records in a manual system in contrast to utilizing a computer for data entry. (mean time spent was approximately twice the hours in a manual system compared to one hour in the computerized system) (Esene, 2015, Krishnan et al, 2010). Again, reports showed some quite minimal acquaintance and understanding of data flow and HIS system processes that could be from challenges related to small sample engaged or framework engaged for the research and their current updated knowledge through trainings (Esene, 2015, Krishnan et al, 2010). Because these studies reports had revealed that training manuals were developed specifically to refresh their understanding of HMIS, they were even used as a key tool for continuous capacity building (Bawa et al, 2003; Esene, 2015; Krishnan et al, 2010).

Though this study did not come without its limitation, the limitation is based on the fact that investigators (same as respondents) who were a part of the system being evaluated or assessed are the same research respondents who conceptualized and carried out the study (Esene, 2015; Krishnan et al, 2010). However, this study has shown the importance of electronic system HMIS as compared to the numerous challenges of the paper system in my opinion and in support to the malaria assessment study being investigated (Krishnan et al,

2010). Though the research emphasized that attempts were made to conduct interviews in a neutral, unbiased way that strengthens study generalizations, the potential for interviewer bias cannot be completely eliminated, particularly given that they are in-depth qualitative interviews. and investigated by same personals (Esene, 2015; Krishnan et al, 2010).

These study responses from both researchers were documented as reported by the participants, and their approximate duration for various tasks during the study process; the respondents indicated that the timing of the research was also subjective (Esene, 2015; Krishnan et al, 2010). In this study, an observational approach would have been an optimal method to genuinely record the time spent by the health workers in comparing both study groups (manual and computerized), focusing key attention and effort on the immediate observation check would have been essential to achieving objectivity and, thus, make findings comparable with other studies (Esene, 2015; Krishnan et al, 2010). Lastly, and most significantly, for both studies there was no definitive indication of how participants were chosen as it was not specified, so generalizing these findings may not be suitable (Esene, 2015; Krishnan et al, 2010).

Another study on health information and the approach on management systems was conducted in Bihar India 2011 by the (United National Population Fund [UNFPA], 2011), which engaged seventeen nine hundred (17,900) respondents from existing health systems to further verify how HMIS tools are manipulated (UNFPA, 2011; Esene, 2015). A single approach of direct engagement was used with a short rapid assessment system directly interviewing 17,900 respondents (UNFPA, 2011; Esene, 2015). This was carried out not only

for HMIS data issues but to also measure training effect on health data staff that involves their familiarity of minimum data sets and HMIS (UNFPA, 2011; Esene, 2015).

Findings from this report using identified six data elements (this includes ANC, OPD, IPT, OCPs, newborn and immunization) demonstrated that this result was examined through a knowledge test assessment on the knowledge of using HMIS registers or tools including effects of in-house training (UNFPA, 2011; Esene, 2015). The results on the knowledge test showed that 74% of the auxiliary nurses and midwives (ANMs) could accurately answer two data elements. out of the six (these finding is very similar to other health workers' HMIS processes study such as Yobe and Indian studies earlier reviewed) assessed and 83% correctly responded to the data elements about still birth data (Bawa et al, 2003; UNFPA, 2011; Esene, 2016). For data elements concerning fully immunized children, reporting on Intermittent Preventive Therapy (IPT) tablets and the number of women utilizing Oral Contraceptive Pills (OCPs), over 91% possessed accurate data knowledge (UNFPA, 2011). In total, 86% of the ANMs collectively had accurate knowledge regarding these six data elements. Additionally, among data entry operators/clerks, the accurate reporting of these selected data elements was relatively lower, with fewer than 75% correctly reporting on three data elements (UNFPA, 2011; Esene, 2016). Other studies and evaluations of health management information systems from sub-Saharan Africa suggest that critical health decisions, in this context, are based on simplistic estimates of disease and treatment burdens because of inadequate quality health information data (Esene, 2015; Bawa et al, 2003; Bawa & Umar, 2009).

The research results from this area indicate that the issue of underreporting is significant and is associated with a deficiency in knowledge and implementation of the HMIS among health personnel, marked by a lack of capacity, inadequate analytical abilities, minimal or nonexistent training, and a lack of motivation to utilize information (Esene, 2015; Bawa and Umar, 2009).

Another study was in conducted 2011 in southwest Ethiopia to assess “utilization of HIS at district level” engaging a large sample of 332 district HF heads (Esene, 2015; Abajebel et al, 2011). The research indicated that 236 (71%) of those surveyed (heads of facility) filled the format properly, while 96 (29%) did not fill correctly had claimed to have challenges and difficulty of understanding distributed HMIS registers and tools (Esene, 2015; Abajebel et al, 2011). The results reported in Ethiopia was a more improved situation in HMIS processes and practice around East Africa than a similar study conducted in Kilombero Tanzania 2008 and Nigeria 2009, the study was among 43 health workers across 11 health facilities will assess their knowledge, practices, shortcomings, and elements affecting changes in the nation's health management information systems (Esene, 2015; Nyamtema, 2010; Bawa & Umar, 2009). The findings indicated that 65% were unable to accurately describe what HMIS entails, with only 7% recalling 7-9 booklets, 18% recalling 5-6 booklets, 42% mentioning 1-5 booklets, and 33% unable to remember even a single one out of twelve HMIS booklets. Over one third (37%) of all participants did not know or possess any knowledge regarding the HMIS information flow pattern. Forty-two percent (42%) of the participants noted that the current HMIS was challenging in completing the registers or comprehending the processes, also being complicated and needing simplification (Esene, 2015; Nyamtema, 2010).

However, the respondents were encouraging and positive according to report findings, but respondents who are health workers emphasized the need for better HMIS system (Esene, 2015; Nyamtema, 2010). Other findings from the study using confidence intervals revealed there was no notable difference in understanding regarding the significance of HMIS among facility clinicians at 61% (95% CI: 41% - 81%) with nurses having a 60% (95% CI: 41% - 81%) (Esene, 2015; Nyamtema, 2010). Further, this report claimed a huge number of study respondents ninety one percent (91%) had positive attitude to using and engaging HMIS which is a very good phase to improve upon (Esene, 2015; Nyamtema, 2010). Also, the report stated that there was no significant difference in attitudes of health workers towards HMIS between clinicians 87% (95% CI: 74% - 99%) and nurses 95% (95% CI: 93% - 98%) as in other reports such the Yobe Nigeria HF study (Esene, 2015; Nyamtema, 2010). Out of the 43 health workers assessed during the study, thirty-nine (39) (91%) concurred that the system (HMIS) justified the time and additional resources invested in filling and processing data, and that it was essential to persevere with the system (Esene, 2015; Nyamtema, 2010). Hence, four (4) (9%) of the respondents showed no interest in continuing with the HMIS (Esene, 2015; Nyamtema, 2010).

Going back to another study on HMIS acceptance and usage conducted in Ethiopia (Abajebel et al, 2011), high percentage of study participants complained that the HMIS or data analysis and direct usage of the health data were left for the supervisor and managers level cadre staff (facility heads) (Abajebel et al, 2011, Esene, 2015). That the duty of the junior staff was only to collect, collate and pass the data to the next levels (Abajebel et al, 2011, Esene, 2015). This is the process where the junior staffs have the impression of not being carried along and lacked a feeling of responsibility in the entire process, this in essence

contributes to the negative vibes displayed and therefore lacks a sense of belonging to HMIS system in Ethiopia as also observed in other countries reviewed (Abajebel et al, 2011; Nyamtema, 2010; Esene, 2015).

Whereas in the Tanzania study (Nyamtema, 2010), Fifty four percent (54%) of health workers interviewed during the research knew exactly the roles and responsivities of staff that were responsible and given the task to utilize information gathered at the health facility, forty-six percent (46%) however were uncertain or lacked sufficient knowledge of HMIS and its significance (Nyamtema, 2010; Esene, 2015). The utilization of health data obtained at the health facility level was further evaluated, with 63% of care providers stating that the main aim of data collection was to “collate and mail” and subsequently dispatch other reports to higher levels instead of analyzing and applying locally to implement health changes and interventions, indicating a significant prevalence of the "mailbox syndrome" as noted in other research conducted in Nigeria and Ethiopia (Nyamtema, 2010; Abajebel et al, 2011; Esene, 2015). In contrast once more to the studies conducted in Ethiopia and Nigeria, the sample size was representative and selection methods were suitable even though the sample might originate from a region in Ethiopia that was involved, whereas the research in Tanzania had a comparatively small sample of forty-three (43) respondents that may not be representative. to the country’s health facility population but appropriate for the purpose of the study on assessing the HMIS in the Liberia malaria intervention (Nyamtema, 2010; Abajebel et al, 2011; Esene, 2015).

In a separate study carried out in 2001 in Dar es Salaam, a region in Tanzania, to evaluate the quality of data gathered through the HMIS with parallels to the present HMIS assessments in this research, the investigation took place in 69 healthcare facilities (41

private and 28 public) (Simba & Mwangu, 2006; Esene, 2015). This study revealed some key findings on knowledge and data collection using HMIS (Simba & Mwangu, 2006; Esene, 2015). This study report showed that respondents or health workers with over average Familiarity with HMIS processes resulted in a higher completion rate of HMIS registers and forms in both government (75. 7%) and private facilities. with seventy three percent (73.2%) compared to those with below average familiarity of the HMIS at approximately fifty percent (49.9%) for government and a little over fifty percent (50.2%) for private (Simba & Mwangu, 2006; Esene, 2015). This study findings of above average similarities were comparable to the study conducted in Ethiopia were seventy one percent (71%) reportedly filled the registers and forms correctly while twenty nine percent (29%) with limited understanding couldn't fill the HMIS forms correctly due to limited familiarity and exposure to HMIS processes, this gap has led to delayed reporting, transcription errors and ambiguities in HMIS reports (Abajebel et al, 2011; Simba & Mwangu, 2006; Esene, 2015).

These studies further demonstrate the significance of ensuring that health staff possess HMIS knowledge and understanding to promote data entry and flow while enhancing data quality for analysis and planning (Esene, 2015; Abajebel et al, 2011). The study conducted in Tanzania in 2006, and the research carried out in Nigeria in 2009 elaborated on essential and relevant findings from private health facilities that were crucial lessons and facts in comparison to findings from public health facilities, leaving an opportunity for further research (Simba and Mwangu, 2006; Esene, 2015). A survey was conducted by Chaulagai *et al* in Malawi to illustrate how the comprehensive health information system had been designed and executed while engaging health facilities (Chaulagai et al, 2005; Esene, 2015). The survey revealed that in spite of the focus on

maximizing data use at local levels, the conventional mindset of gathering data solely for reporting purposes remained deeply entrenched in the system, akin to what other studies have suggested in developing countries (Chaulagai et al, 2005; Abajebel et al, 2011; Esene 2015).

Some facility staff and health workers who are respondents in the research highlighted being regarded as tools for the submission of reports as the primary goal of the information system following data collection on their end; this perception persists due to insufficient training in underdeveloped or data-challenged nations (Chaulagai et al, 2005; Abajebel et al, 2011; Bawa and Umar, 2009). The same facility staff who handle and provide services gather the routine data pertaining to their own work performance; hence, there is no opportunity for an honest evaluation of the processes (Chaulagai et al, 2005; Abajebel et al, 2011; Esene, 2015). Once more, this reflects the same mentality or is akin to the "mailbox" syndrome noted among participants in the study conducted in Tanzania in 2008, where data are gathered merely to be sent to the next level without its application (Nyamtema, 2010; Abajebel et al, 2011; Esene, 2015). Malawi health ministry's mindset behind design and use of Malawian HMIS structure was not far from the systems in Nigeria, Ethiopia and other third world countries that is targeted at services providers and facilities who compile information, as data staffs and senior programme staff should be the first users of the information to make key decisions that affects planning (Abajebel et al, 2011; Esene, 2015).

The key expected outcomes and philosophy behind these findings, as found in the studies, come from the reality that the service providers who are the primary data collectors ought to adopt ownership and a feeling of belonging with the current HMIS processes and structure, refraining from developing a negative attitude toward the HMIS processes

(Chaulagai et al, 2005; Bawa & Umar, 2009). Service providers should not be led to believe that they are solely responsible for data collection when it is required (Esene, 2015; Chaulagai et al, 2005).

Some additional research conducted in Nigeria between 2003 and 2009 regarding the utilization of HMIS and its functionalities revealed that the level of awareness of HMIS and attitudes toward data collection and HMIS were either limited or low, except in health care environments where deliberate efforts have been made to consistently educate and inform health workers about data flow, data demand, data collection, and the significance of HMIS (Bawa et al, 2003; Bawa and Umar, 2009; Esene, 2015). Similarly, there was a study conducted in 2003 among six LGAs in Yobe State, Nigeria by Bawa et al. to evaluate one hundred and forty-four (144) health workers regarding disease surveillance practices and data collection (Bawa et al, 2003; Esene, 2015). This research indicated that fifty-five (55), which represents 38. 2% of the participants were familiar with the structured national disease surveillance system known as DHIS2 that utilizes HMIS tools (Bawa et al, 2003). The awareness of the respondents was classified using a mean score concerning immediate notifiable diseases recorded in the study as 0. 8 ± 1. 23 SD (out of a maximum of 10) (Bawa et al, 2003; Esene, 2015). Of the respondents, 39 (70. 9%) stated that they had reported using the HMIS, whereas 16 (29. 1%) reported not having submitted any of the notifiable conditions using HMIS (Bawa et al, 2005). The study also assessed the extent to which respondents (health facility staff) had received feedback on reports submitted to supervisors via HMIS platforms. The data from the respondents indicated that there was only a relatively low number of twelve (12) (21. 8%) claimed to have received feedback from submitted

reports sent through DHIS platforms at either regional or national levels, as identified in other studies as well (Bawa et al, 2005; Essene, 2015).

Further, analyses from another study but some respondents showed same kind of responses from research conducted 2009 by Bawa & Umar in Yobe State (Bawa & Umar, 2009). Findings from this study revealed functionality and status of disease surveillance system referring to HMIS at health facilities and the results showed fifty-eight 58 (65.9%) and seven 7 (8. 0%) of these facilities maintained current data in HMIS registers and other health service tools respectively (Bawa et al, 2003; Esene, 2015). Furthermore, that data analysis is not carried out by the health personnels of the facilities at the LGA level but at a central level (Bawa & Umar, 2009; Bawa et al, 2005; Esene. (2015).

This was very different to findings from same kind of survey done in Enugu State an eastern part of Nigeria, where the survey was carried out to evaluate health data records and reporting systems in 2008, data flow structure, report and data use gauging 17 Local Government Areas (LGAs) (Ekwueme, 2008; Esene, 2015). The results, as revealed, were a direct opposite of the situation in the Yobe state assessment, showing sixty-one (61.1%) of the evaluated HFs to have analyzed their data at the facility level, but data use was not verified at this point (Ekwueme, 2008; Esene, 2015). In my own opinion the comparatively significant number of HFs that have used its data structure to analyze facility data at that level in the Enugu state study, could be because of regular training and ongoing mentoring on data collection and HMIS processes or having knowledgeable data experts (Ekwueme, 2008; Esene, 2015).

The 2008 Enugu study of 2008 that assessed health data records and recording systems, reporting and data use. Also, data use and attitude of some health workers

numbering 107 PHC at same 17 LGAs were assessed to determine use of HMIS data report tools and their knowledge on the core National Minimum Data sets (cNMDS) as indicated by Ekwueme (Ekwueme, 2008; Esene, 2015). cNMDS were introduced to participants during the study to further evaluate participants awareness, study findings revealed PHC workers who had over fifty percent 50% familiarity of 5 data sets out of 13 minimum data sets of NMDS using parameters were: awareness of NPI was eighty seven percent (87%), while ANC and Pregnancy outcome awareness was seventy nine percent (79%), Growth monitoring and promotion was sixty-three (63%), while family planning and outpatient attendance were fifty six respectively (56% each) (Ekwueme, 2008; Esene, 2015). The respondents' understanding of the other 8 minimum data sets was under 50% at 47%, with an average knowledge percentage on the 13 cNMDS being 39. 5% as shown by the study (Esene, 2015). On average, the research suggested that it was merely 25. 2% of the PHC workers were aware of the types and different uses of HMIS forms, specifically 000, 001, 002, and 003 (Ekwueme, 2008; Esene, 2015).

The research also explored the perceptions of the PHC workers regarding the utilization of HMIS forms and reported that the response was predominantly negative, as 60. 7% of participants indicated a lack of interest in completing the forms, while 48. 6% considered the task unnecessary and time-consuming (Esene, 2015). These results regarding inadequate knowledge and attitude towards data collection and HMIS utilization led to an experimental study conducted in Enugu in 2004, aimed at assessing the impact of training health workers on HMIS tools, data collection, reporting, and utilization (Ekwueme & Aghaji, 2008; Esene, 2015). Two study control groups, consisting of 57 and 50 individuals from distinct facilities, were established, and the results indicated that both groups

recognized the presence of the HMIS; however, the attitudes towards data collection for HMIS, as documented in the study, were similarly negative in both groups (Esene, 2015; Ekwueme and Aghaji, 2008). Data illustrated that the proportion of the study and control groups identifying the essential items of the National Minimum Data Sets that needed to be collected at the PHC level was 80% and 82% for one and two items, 50% and 69% for four items, and 25% and 44% for three and five items, respectively, for both groups (Esene, 2015). The practice of health workers in data entry using HMIS forms, registers, and exercise books was also evaluated. Seven (77. 8%) and (66. 2%) of both control health centers (groups) respectively recorded data and maintained monthly health center copies of HMIS form 000 at the facilities (Esene, 2015; Ekwueme and Aghaji, 2008).

Although both health center registers and forms were not fully or accurately completed, nor were they maintained in a current state (Esene, 2015). After the intervention, the documented and visible practices showed considerable improvement ($p<0.0001$) (Esene, 2015; Ekwueme and Aghaji, 2008). This study findings and report did not detail or record how participants were chosen and paired for both the research and control groups, and how the samples respondents were selected and matched in both studies were not available for review (Esene, 2015). However, the report stated that these groups were trained or had their capacity built of 2 weeks before the study. And so, it provides space for additional research to determine the reasons behind respondents' indifferent interest in completing the HMIS forms (Esene, 2015; Ekwueme and Aghaji, 2008).

Research and social investigations have shown that some developing and developed countries have achieved a good form of progressive health information systems and its structures that guide informed decisions for health services and policy formation (Azubuike

& Ehiri, 1999; WHO, 2007). These investigations, however, emphasized how some countries who fight diseases in health systems are yet to establish effective and functional HIS structures, especially less developed countries that include Africa (Azubuike & Ehiri, 1999; WHO, 2007).

Therefore, some forms of interventions or disease planning and implementations of health programmes in underdeveloped or developing countries like Africa seem to be conducted with limited or insufficient information about population and its trend, this gap has also led to researchers and international donors questioning quality of data in planning (Azubuike & Ehiri, 1999; Mboera, 2021). Hence, the perception that program and disease interventions might have been based on low quality data for implementation due to fear of incorrect information or inadequate data gathering that is incomplete and on estimations and guesswork (MEASURE, 2019). This condition has often led or contributed to issues around data accuracy, quality plan, and setbacks in providing quality health services to the population Yaser et al. 2019; MEASURE, 2018).

Factors affecting practice and utilization of data and HMIS

In the field of data demand and usage, numerous authors in existing literature have contended and have also reached a consensus that the training and human resource development of health personnel concerning data and HMIS is a crucial factor in enhancing health personnel's knowledge, which in turn improves and sustains their practice in the utilization of HMIS (Mehmood et al, 2011; Esene, 2015). This issue has surfaced due to various challenges and ambiguities surrounding the many available data tools, collection instruments, and software, as well as the lack or insufficiency of health infrastructure such

as computers and other resources to address the HMIS shortcomings related to HMIS funding or specific budgets (Esene, 2015; Mboera, 2021).

Some identified determinants as recorded by these studies include various educational level recorded for health personnel and health personnel's period of experience on the job (UNFPA, 2011; Esene, 2015) others comprise understanding of their job role, offering incentives and compensation for additional time or effort contributed to the HMIS (Esene, 2015; Simba & Mwangu, 2006). Other key factors as described by these studies are the tedious aspect of inputting data into the HMIS logs, especially the manual processes of paperwork as well as electronically into the software (Esene, 2015; Simba & Mwangu, 2006). Lack of feedback on data collected to the facility staff was also emphasized as a key set back, availability of supervision, fear for penalties as minimum data result of poor entry of data was also itemized (Simba & Mwangu, 2006; Chaulagai et al, 2005).

Using information to make decisions

This study emphasizes that information is a tool for improving decision-making in areas like policy development, health planning, and management, not an end in itself. monitoring, and evaluation of programs and services, such as patient care, in order to enhance the performance and outcomes of the whole health service.

There are two implicit premises behind information systems: first, that once good data is accessible, it will be turned into useful information that will then have an impact on that choices made on the basis of such information will result in a more efficient and sensible utilization of limited resources via improved procedures, programs, and policies (Lippeveld, 2018). Secondly, the execution of which will produce a new set of data that will then drive additional choices, and so forth in a spiral manner change intervention approaches and

planning (Lippeveld, 2018). At the patient care, health unit, and system levels, this broad perspective of the connection between information and choices is applicable (Lippeveld, 2018).

Most would agree that information can only sway choices if it is timely, relevant, and accessible to the decision-maker (Lippeveld, 2018). The sad truth is that even when this kind of excellent material is available, its correct application in the decision-making process is not assured (Lippeveld et al, 2018; Measure, 2018). Data underutilization is the subject of several anecdotal stories in information literature and data challenges in Africa, especially circumstances in planning for diseases in developing countries (Lippeveld, 2018).

As a result, one of the goals of this study is to equip health system employees with methods to improve their information use. First, the study identifies several applications and users of information in order to accomplish this. Then, the study focusses on the wider question of how policymakers, planners, and healthcare professionals make choices inside of institutions, as well as the function of information in this process using quality information. The study then on to finish with a discussion of realistic strategies to improve information usage.

What is wrong with current health information systems?

Regretfully, most nations' health information systems are unable to supply the essential administrative assistance that WHO recommends (Lippeveld et al, 2018; WHO, 2015). In addition, the data received is frequently not helpful for management decision making (could be either incomplete or over reported) as described by (Measure, 2018) report, and reports are sent out weekly or monthly without sufficient input (Lippeveld et al, 2018; Measure, 2018). This means, data systems could be incomplete, incorrect, out of date, and

unrelated to the priority jobs and responsibilities of local health workers and tend to be not “data driven” instead we have "action driven" (Lippeveld et al, 2018; Measure, 2018). A large amount of the data gathered is transmitted to the national level without being analyzed and is often utilized and ends up on dusty shelves of offices as observed by (Lippeveld et al, 2018; Measure, 2018) in their reports. Present health information systems are Hence, rather than tools, the causes are generally seen as management challenges (Lippeveld et al, 2018; Measure, 2018).

In the past, information needs were mostly at the national level, such as statistical reports that mainly focused on assessing facility-based illnesses (Lippeveld et al, 2018; Measure, 2018). In response to growing financial limitations in the healthcare industry and a heightened emphasis on decentralization and democracy, there has been a movement toward more knowledge across the whole range of health care management (Lippeveld et al, 2018; Measure, 2018). Recent trends have demonstrated that defining information needs should be based on consensus building between all stakeholders involved in data collecting and utilization. the data generated; both patients and health service providers concerns must be considered (Lippeveld et al, 2018; WHO report, 2015; Measure, 2018).

According to a WHO Expert Committee meeting report in 2025, a large portion of the information that the health service workers record and report is not essential for the jobs they do. Data collection focuses mostly on disease reporting and only addresses a portion of management objectives at the health unit or patient/client level (Lippeveld et al, 2018; Measure, 2018). But sometimes the data needed is not collected. Health information systems, for example, often lack sufficient metrics for tracking the continuity of care for particular patients or clients (Lippeveld et al, 2018; DQIP, 2022 - 2027).

A lack of consensus between data and use at all levels of the healthcare industry is the common thread running through these two observations of the type of data that the care system needs and operates on for systems strengthening (Lippeveld et al, 2018; DQIP, 2022 - 2027).

In addition, data flow system and information could be worrisome if not well managed, because data could be typically so boring to transmit, compile, analyze, and present DQIP, 2022 – 2027; Measure, 2015). Program decisions are sometimes made without any informational input from the data source or clerks themselves, and they can cause issues around data quality and planning (Lippeveld et al, 2018; DQIP, 2022 - 2027).

In their daily decision-making, planners and managers are subject to time constraints and deadlines, hence they might miss out on quality information even if it's of good quality (Lippeveld et al, 2018; DQIP, 2022 - 2027). The existence of robust vertical programs frequently results in data transmission delays and a lack of feedback at the district level, reasons why Health facilities submit data straight to national program managers in some instances while district-level line managers only get stale feedback reports, if at all (Lippeveld et al, 2018; DQIP, 2022 - 2027).

Capacity building and training

Capacity building and training were among the most clearly addressed and prevalent determinants recognized across the board in all the studies examined as a crucial element influencing the practice and use of the health information system in the Primary Health Care facilities (Simba and Mwangu, 2006; Esene, 2015). Limited capacity building and insufficient training with its resulting impacts were also noted and discussed in this survey carried out in Pakistan in 2004, this survey explored capacity building and perceptions of

thirty health managers on the use of HMIS like the study conducted in Nigeria by (Qazi & Ali, 2009; Esene, 2015). These studies discussed lack of trainings and refresher activities that would have strengthen the HMIS system in Pakistan and Nigeria, revealing that the final refresher course took place five to ten years ago (Qazi & Ali, 2009; Esene, 2015). This is identified as a significant element by respondents and the study for the inadequate knowledge and implementation of HMIS (Qazi & Ali, 2009; Esene, 2015).

The findings from the study further discussed how updated and regular training improved Knowledge and practice in line with changes in the system, this improvement was observed on health personnel and Software for upholding the HIS framework as noted in the 2008 cross-sectional study conducted in Pakistan (Esene, 2015; Mehmood et al, 2005). The research aimed to evaluate the current HMIS procedures implemented in the Basic Health Units of Tehsil Taxila. as introduced earlier in PHCs at Edo Nigeria where training was steady and continuing (Mehmood et al, 2005; Esene; 2015). The same study observed and outlined that 76% of the staff in the health facilities were trained regularly on HMIS data entry while 24% had never received any form of formal training (Esene, 2015). Further, the study report indicated that training and sensitization while at work on the job was done for just 8% of all health facilities staff, while 20% had never been engaged in training activities (Esene, 2015; Mehmood et al, 2005). The report further discussed the findings regarding scheduling training to ascertain a futuristic change, but no schedule of training was found for current data entry staff or health personnel who were involved in any form of HMIS data entry (Esene, 2015; Mehmood et al, 2005).

Analyzing a 2012 survey conducted to assess the Indian health management information system, in furtherance of results around capacity building as it affects HMIS

data collection and use (Esene, 2015) some findings further buttress the gaps identified by other aforementioned literatures and studies, the Indian survey elaborated on Various tiers of personnel engaged with the HMIS revealed shortcomings in training and staff development (Esene, 2015; Bodavala, 2012). Key data experts whose major roles were to use the HMIS and state level data staff who supervisors were affected in this practice of data input since they possessed a limited understanding of the registers. During a separate review in 2011 of the rapid assessment conducted in Bihar, India among 17,900 respondents, the study evaluated the impact of training on the knowledge of the minimum data sets and HMIS, revealing that 97. 5% of the auxiliary nurses and midwives (ANMs) and 89% of data entry operators (DEO), block health managers (BHM), and data processing managers (DPM) received various types of technical capacity at different times (Esene, 2015; Bodavala, 2012). Even though the staff and facility selection for the training was not really explained as per its methodology, the population sample was not clear at the point of this review.

In gathering information on HMIS capacity and in developing countries, such as the African continent, this study reviewed key research and articles from Ethiopia and Tanzania regarding Ards systems strengthening for HMIS. The findings were not really different from other developing countries globally; same situation was observed in an Ethiopian study conducted in 2009 around Southwestern Ethiopia. Practice of data entry since they had a limited grasp of the registers. Similarly, in India, during another 2011 evaluation of the rapid assessment conducted in Bihar, India, involving 17,900 participants, the study examined the impact of training on awareness of the minimum data sets and HMIS. It revealed that 97. 5% of the auxiliary nurses and midwives (ANMs) and 89% of data entry

operators (DEO), block health managers (BHM), and data processing managers (DPM) received some type of training at various times with support and experiences to carry out this role (Abajebel et al, 2011; Esene, 2015). These findings were however not different from the findings discussed in the other research study conducted in Tanzania 2006 (Simba & Mwangu, 2006). The survey in Tanzania was conducted among 43 health workers to identify their knowledge-practice discrepancies and factors that could lead to changes in the country's HMIS, which also revealed some key findings that will be discussed in the course of this study (Nyamtema, 2010; Esene, 2015), this was also indicated at the earlier part of this review, but the focus will be on capacity strengthening for HMIS, the study discussed that a huge fraction of 81% of those surveyed had never received any form of training or capacity on HMIS (Esene, 2015).

In this observation, the findings indicated that a notable percentage of approximately 65% of health workers were unable to accurately define HMIS, while 42% of the participants stated that the forms were challenging to comprehend and complete (Nyamtema, 2010; Esene, 2015). Most importantly, the report from the research revealed that there was no evident significant difference between the percentages of health workers trained in HMIS and the clinicians, as the study statistics and proportions demonstrated 17% (95% CI: 2% - 32%) of health workers and 20% (95% CI: 2% - 38%) of nurses (Nyamtema, 2010; Esene, 2015). Nevertheless, again referring to the study carried out in Malawi 2005, result has described how the all-inclusive health information system and management designed had been implemented (Chaulagai et al. 2005). This step should have given a very positive improvement to the health management information system, but findings showed that despite so much effort put into training, there was no major or significant difference observed

between the performance of trained and untrained health workers but how this difference was measured was not clearly discussed (Chaulagai et al, 2005; Esene, 2015). This Malawi study still emphasized key findings in some facilities that is of significant importance, it claimed that performance of some newly recruited officers as observed during this study was better as compared to some old staffs already trained for 5 days on HMIS (Chaulagai et al, 2005).

This study further in its finding evaluated quality of collated data and analysis by facility staff that have been mentored or had on the job trainings, results of analysis pattern and format used to disseminate findings showed staffs had better performance and that means staffs could perform much better with on-the-job training sessions, than some other colleagues trained using classroom approach (Chaulagai et al, 2005).

These studies in Africa compared to other developing countries like India has a different mindset and approach to the HMIS, this information was discovered in the research carried out in Bihar, India by UNFPA in 2011 to evaluate the impact of training on knowledge regarding the minimum data sets and HMIS (Esene, 2015; UNFPA, 2011). The findings noted in India indicated that nearly all categories of respondents viewed their training as beneficial for utilizing the HMIS and making informed decisions, with approximately 50% of the ANMs concurring and stating that it has improved their understanding of HMIS and various data elements, as well as clarified uncertainties in completing the revised HMIS reporting format (Esene, 2015; UNFPA, 2011).

Also, about 50% of the BHM respondents agree that accuracy and timeliness had improved as a result of the training while the other one third were also in agreement that the capacity building and mentoring including training has supported their technical skills in

resolving numerous questions on different data components (Esene, 2015; UNFPA, 2011). More research will be done using different countries and groups to further explore possible factors and potential analysis that could be leading to these results on HMIS system strengthening and practice as also described by Esene in the Edo Nigeria HMIS study (Esene, 2015). The Liberia situation will further help to explore if there has been changes or improvement in the use of HMIS in data demand and use, also if capacity plays a part in HMIS practice.

Supervision and mentoring

Authors and researchers also discussed other forms of determinants to HMIS practices and use, however some of the studies also narrowed down on supervision and such study is the 2004 cross-sectional study in Ace province Taiwan and PHC study in Nigeria will evaluate the knowledge and capability of hospital personnel in utilizing electronic health information systems among 3,358 respondents (Esene, 2015; Thi et al, 2010). The study in its findings fingered and pointed out that one of the key factors influencing and will influence HMIS implementation and use was more of managerial support and supervision, in the report it emphasized that this is one of the very essential elements affecting HMIS implementation (Thi et al, 2010). These studies also emphasized that facilities where the managers themselves encouraged the implementation of the system and oversaw the movement under their supervision, generally employed and utilized the system, were entirely employed and with increased success than areas where supervision is limited (Thi et al, 2010; Esene, 2015).

Further, these health systems and process assessment conducted in Vietnam expressed that factors surrounding health management information systems were multiple and it varied with different facilities (Thi et al, 2010). Some important factors were

pinpointed that reduced the inconsistency among data collection forms and the misalignment between the forms and the Ministry of Health's software for HMIS (Medisoft) were the factors impacting their comprehension and implementation (Thi et al, 2010; Esene, 2015).

This Vietnam study reports emphasized how negative the HMIS impact has been in the country as all the facility personnel (100 of the respondents) accountable for data management across various levels of care, responded in their replies to the challenges encountered in data entry. from the data registers and forms into the software, then exporting the data to reporting forms because of inadequate comprehension of the HMIS software (Esene, 2015; Thi et al, 2010). Another finding was the feedback loops in the HMIS system, the respondents claimed that the feedback loops were always incomplete as staff do not know if what was submitted is correct or not at any point in time (Thi et al, 2010). The respondents according to the study claimed that data officers from the service providers at the facilities do receive feedback from the provincial level solely when the information they provided was unusual (Esene, 2015; Thi et al, 2010).

As the central level hardly sends feedback after receiving the HMIS report or data, meaning facilities either do not have opportunity to assess data for planning or cannot evaluate kind of services provided to the population or appreciate outcome on health information that has been gathered, which has ultimately resulted in affecting staff morale and poor HMIS practices (Thi et al, 2010). As helpful as these studies in understanding factors affecting HMIS and possible ways to improve the systems may be, there was no detailed protocols or methodology to how respondents were chosen for evaluation and therefore extrapolation of results may be affected.

Focusing on Africa, diverse health supports have been received on health management information systems and data use through international donors and funders, The transformation of health information systems is regarded as progressively emerging as a priority in health systems interventions and administration across numerous African nations. as described (United Nations Health Matrix Network [HMN], 2005). This development is yet to attain its full potential and deserves careful attention in other to harness health systems profit of good health especially for lesser developed countries, some key challenges in developing countries HMIS are described by (Mboera, 2021; Salangwa, 2025; Esene, 2015; WHO, 2015) and demonstrating the effect in producing quality data for planning. Health data and management is yet to attain its full potential in Africa due to the relatively high cost of affordable quality health care and the lack of dependable health information needed to guide planning as described by the world health bodies (Mboera, 2021; Salangwa, 2025; Esene, 2015; WHO, 2015).

Some of these challenges and setbacks to establishing effective health care systems and quality information gathering processes in Africa could be traced down to expertise, finance and staffing (Achoki & Lesogo, 2016; Mboera, 2021). Though, (Jalghoum et al, 2019) claimed that there could be several reasons that have ladened the progress of HIS implementation in countries, and this could include difficulty in securing privacy and security of patients' information, poor handling of electronic healthcare data, expenses regarding technology acquisition, stakeholders' comprehension and opposition to technology, absence of standardization of data or information gathering processes and analysis (Jalghoum et al, 2019). Further, another major defect in health data and information is minimal and relevant research done in these areas of introducing technologies like

information systems in national health systems as argued to be another major challenge (Archangel, 2007).

The disease burden in Africa and other countries has led to common thinking around disease management and decrease and methods to establish a unified approach; this has led to two key areas or challenges that must be attended to. The first will be to generate reliable, accurate and appropriate information that is made available promptly as a foundation of health practice, as described by Molly et al in combatting HIS in health (Molly et al. 2013). The other key area in global health challenge is using such information by decision-makers and decision-making processes (Forest et al, 2006). These challenges have given rise to several initiatives to urgently address the issues causing difficulties recognized, such as the urgent Health Metrics Network by (WHO-HMN, 2005). That was later dissolved in 2013 due to the inability of countries to entirely pull their weights and catch up, according to the WHO-HMN, 2008). This initiative was intended to build robust health information systems for decision, policy formation and planning.

This is a typical starting point for these two challenges in developing and strengthening health information systems at the country level and providing high-quality primary data with health facilities as a critical source of health data and information for health planning decision, as suggested by an earlier study (Forest et al, 2006). As (Azubuike & Ehiri, 1999) also emphasized earlier at the start of introducing HIS that:

"*Health information systems play a crucial role as supportive tools in the management of health care service delivery in both developed and developing countries. A sufficient health information system is essential for evaluating the health requirements of populations and groups, as well as for the planning and execution of health interventions.…. "(*Azubuike & Ehiri, 1999, p28)

also expressed that achieving useful health services statistics to inform decisions in health care systems will significantly improve health care planning and services.

This is why health information has been supported in emergent countries, and it's evolving but in somewhat chaotic and fragmented ways (Azubuike & Ehiri, 1999). This information challenge has occurred due to data collection inconsistency, lack of capacity, and disorganized data flow systems, as argued by Forest. et al. (2006). Hence, quality information that is needed for key health decisions for stakeholders will either remain unavailable, unreliable, or insufficient, like (Forest et al, 2006) explained.

WHO HIS document has stated that, *" The health information system offers the foundation for decision-making and includes four essential functions: data generation, compilation, analysis and synthesis, and communication and use. The health information system gathers information from the health sector and other pertinent sectors, examines the information, guarantees its overall quality, relevance and promptness, and transforms information into knowledge for health-related decision-making "*(WHO, June 2008).

Health and information with its structure and processes have shown to be most crucial and interrelated building blocks needed in a health system (WHO, 2007; Mboera, 2021). This report also emphasized that a relevant and functioning HIS or data system would produce dependable and on time information for health intervention planning, including health policies and health system performance that can generate pertinent analysis to direct implementations throughout all other health system building blocks (WHO, 2007). Therefore, an effective HIS allows decision makers at every level of health to recognize challenges, gaps, and significant progress that fosters critical data-driven decisions regarding health policies and programs (WHO-HMN, 2005; Mboera, 2021). Most significantly, allocating scarce resources is a huge challenge in developing countries (WHO-HMN, 2005; Achoki & Lesogo, 2016).

Understanding that weak HIS as described by Measure becomes a significant obstacle to achieving the health-related Sustainable Development Goals is the routine assessment of health facility data, which has been recognized as an essential issue in the completeness, accuracy, and timeliness of Health Information Systems in the healthcare environments of developing countries. and structures (MEASURE, 2019; UN-SDG, 2015).

Again, to pay more emphasis to (Azubuike and Ehiri, 1999) in describing health information systems as *"a key and important tool to support in managing health care services delivery in developed and less developed countries.…*." (Azubuike and Ehiri, 1999, p28). This study in its submission has claimed that a functional HIS is vital for evaluating the health requirements of populations and vital decision-making that supports the planning and execution of health interventions (Azubuike and Ehiri, 1999). It is essential and highly effective to assess programs from the viewpoints of completeness, effectiveness, and coverage (Azubuike and Ehiri, 1999).

As a result of these data challenges and information used for planning and deficiency in policies formation in Liberia and other developing countries the WHO initiated the Health Metrics Network in 2005 to aid in fortifying the malaria information and health systems that improve policies and planning. This HMN is the first global partnership to support systems to generate health-related information for data informed decision in health services (UN-HMN, 2005). The HMN framework aims to bring partners together and align them around a consensus framework for enhancing and developing health information systems (UN-HMN, 2005).

Its declared purpose was *". . . that by 2011, this Framework and Standards for Country Health Information Systems (the "HMN Framework") will be the globally recognized*

standard for directing the collection, reporting, and utilization of health information by all developing nations and international agencies. . .". (UN-HMN, 2005, p6).

Even though some countries used the HMN to assess current health information system, its purpose was not met and was dissolved in 2013 as reported by the (UN-HMN, 2005). Attempts to enhance national health information systems lingered for an excessive duration in countries due to a lack of readiness in structures and staff capacities. (UN-HMN, 2005). Challenges still exist around the health information systems' immediate issues, such as systemic issues that have cost countries poor data collection processes and decision-making (Measure, 2012; UN-HMN, 2005).

Though, some countries use HMN to assess their health information system. There are still challenges around the health information systems' immediate issues, such as systemic issues that have cost countries poor data collection processes and decision-making (Measure, 2012).

Several countries reported to have used the HMN process and framework to assess their health data information systems (UN-HMN, 2005). However, these assessments do not explore the factors underlying identified weaknesses. They focused on immediate issues within the health information system, but adequate attention to historical antecedents that may affect the HMIS, and decision-making needs to be improved. In this light, difficulties in strengthening it effectively and sustainably health management information system may arise.

Many scholars, including (Azubuike & Ehiri, 1999; Molly et al, 2013; Mahmood & Muhammad, 2010; Esene, 2015) globally agree that the Health Information system can provide many benefits because consistent and sensible health information on derived from

quality intervention coverage has been a significant fulcrum of public health practice. If properly addressed, it will increase health accountability and enable bodies to improve monitoring abilities to properly measure advancement toward fulfilling worldwide and significant domestic, aims and targets (Molly et al, 2013).

Quality of HMIS Data

In an attempt to have quality data for planning and informed policy formation as (Lippeveld et al, 2000; Anthony, 1984) agrees, the Liberia national framework 2023 to 2030 also agrees that correct and quality data produces apt and dependable information for planning (Rapid Services Quality Assessment [RSQA], 2014). And in order to strengthen data quality and improvement to the quality of services (QoS) at the health facility and country level, resulting in the attainment of dependable data for planning, the UN frameworks and Global Fund interventions led the Rapid Services Quality Assessment (RSQA) co-led by the WHO in 2014 to improve planning data.

With the objective to support developing countries and produce real time quality data that are reliable for planning in the health sector and reform, since DHIS2 instance or platform is mostly depended on and used for planning and data is aggregated through the HMIS tools. It then very paramount to engage quality of data that produces reliable information for proper planning and decision making, as it becomes very critical for this study to engage a review of and explore how quality of data affects HMIS and data use (Measure, 2018).

The cumulative impact of health data and the combined effect to enhance the value and appropriateness of data is observed in this qualitative study reviewed, which examines the data perceptions and practices of 30 health managers concerning HMIS conducted in 2004

in Pakistan on data quality (Esene, 2015). This study discussed the various variations and transcription errors during data entry; issues around likely determinants and challenges were further discussed in the study (Esene, 2015). One of the biggest issues this study revealed was the comparison between the HMIS registers and forms with the national platforms that are not compatible, and so at all levels there were challenges where many physicians did not record the age of their patients because of the lack of that section on the forms (Esene, 2015).

Also, the diagnosis of the patients had limitations and did not record properly forming gaps on the accuracy of data and limiting data quality (Qazi & Ali, 2009; Esene, 2015). The participants in the study indicated that there were gaps in coordination both between departments and within departments regarding information sharing and peer learning, resulting in multiple instances of unreliable, duplicated data (Qazi and Ali, 2009). While examining the precision of the reports in the analysis of the current HMIS utilized in Basic Health Units, (Mehmood et al, 2011) found that data accuracy produced at the PHCs, although timely, was sometimes incorrect (Esene, 2015). According to the study, one observation related to timeliness indicated that 100% of cases were recorded and submitted monthly through facility reporting as per the established schedule, yet only about 70% were accurate in terms of completeness (Esene, 2015). An additional crucial aspect of data quality is the promptness of submission, which was also assessed in this literature by means of a study conducted in Pakistan in 2009 that sought to evaluate the accuracy of reports submitted by 40 lady health workers (Mahmood & Muhammad, 2010; Esene, 2015). These reports were monthly reports that were conducted and received in health facilities and must be the first week of every month (Mahmood & Muhammad, 2010; Esene, 2015).

In this 2010 Pakistan study, it revealed that only 75% of the instances on the LHW reports were recorded in the entries though the submission were verified from record registers, but submission rates was 75% (Mahmood & Muhammad, 2010). As regards completeness, this report in its analysis showed hat 57. 5% accurately reflects the total catchment population while 17 (42. 5%) were either under reporting or over reporting the details. making the report either inaccurate or unreliable to claim completeness (Mahmood & Muhammad, 2010; Esene, 2015). Again, about 47.5% of the monthly reports according to the study were classified as precise and of a high-quality report while 35% of these monthly reports were deemed insufficient and incorrect giving the data a below par in data quality (Mahmood & Muhammad, 2010; Esene, 2015).

This level of accuracy was considered low when compared to the Pakistan 2008 cross-sectional study that evaluated the HMIS at the basic health units in Taxila, Pakistan, which demonstrated 70% accuracy (Esene, 2015). (Mehmood et al, 2011) reported these results despite the continuous training and supervision among the participants in the 2011 study in Pakistan, which had a relatively limited sample size (40) and might account for the comparatively low proportions (Esene, 2015). Furthermore, the 2010 study involving LHWs in Pakistan revealed that upon verification, 17. 5% of the workers were over-reporting, while 22. 5%, 12. 5%, and 10% were under-reporting immunization, maternal deaths, and infant deaths respectively (Mahmood & Muhammad, 2010; Esene, 2015).

It is praiseworthy that in the 2010 research conducted in Pakistan, the instrument for evaluating data quality utilized in this study was founded on the World Health Organization standardized and validated method referred to as “Data Quality Audit” to evaluate the precision of health data gathered at Primary Health Care facilities (Esene, 2015). It entailed

monitoring data from the Federal level down to the Primary Health Care units to compute a ‘Verification Factor’ which is regarded as an indicator of data precision (Mahmood and Muhammad, 2010; Burnum, 1989; Esene, 2015). This provided credibility to this research in its evaluation of data quality (Esene, 2015).

Different articles and researchers have described and noted that with ongoing or regular training and oversight that aids health facilities, including the quality of data enhanced in terms of completeness and accuracy as observed in the Bihar 2011 study in India, which was carried out among 17,900 health workers to evaluate the impact of training on understanding of the minimum data sets as it bolsters data quality and HMIS data contributions (UNFPA, 2011; Esene, 2015). The study in its findings has examined the comprehensiveness of the disease data elements in the HMIS reporting for the regions as a whole, the report outlined an increase in completeness previously 38% previously to an increased 54% for the same reporting period within a year (UNFPA, 2011; Esene, 2015). This was also in different from the earlier mentioned study of the case in the Pakistan 2010 study involving 40 LHWs, where a 47. 5% enhancement in completeness was noted at the facilities (Mahmood & Muhammad, 2010; Esene, 2015).

The statistics from the 2011 India study provided a clearer breakdown showing that 64% of the ANMs had updated their entries in daily diaries by July 2011, and a better proportion of the ANMs have successfully updated entries in Routine Immunisation, Maternal Child Health, and Family Planning registers at 58%, 53%, and 39% respectively (Mahmood & Muhammad, 2010; Esene, 2015). Only 15% of the data entry ANMs operators reported facing challenges related to the incompleteness of the reports submitted by the ANMs (Esene, 2015). The observed advancements in data practices and data quality in both

studies could be credited to the regular trainings and capacity building that the respondents underwent, as indicated by the study (UNFPA, 2011; Esene, 2015). This same situation was evident with the LHWs in the 2010 Pakistan study since, despite both supervision and regular training provided to participants, there were still reports of 20% over reporting and 22. 5% under reporting as noted in the study (Mahmood & Muhammad, 2010; Esene, 2015).

In considering a current and well-organized health information management with quality data or that ensures quality data are collected, collated, and inputted into the DHIS2 platform, uniformity of data must be ensured making sure data quality consistency checks are integrated into the forms and system to prevent the entry of invalid data (Esene, 2015). Additionally, to guarantee and allow consistency checks in human forms as it relates to supervision and On-Site Data Verification exercises (OSDV) (Esene, 2015). In addition, this Data Quality Assurance (DQA) system could ensure a programmed system to completeness of data on the HMIS tools and DHIS platform which already exist but left for the understanding of the data entry staffs. This will help curb and help to ensure forms that lack appropriate entries in the required fields cannot be saved or transferred unless they have been properly and sufficiently completed (Esene, 2015; Asangansi et al, 2003). Through these mechanisms, the health information systems are ensured of data collected to guarantee good quality (Asangansi et al, 2003; Esene, 2015). In addition, as agreed by the HMIS authors that linkages of the data from the districts to regions and national databases will be accomplished through a feature the systems team has developed that permitted data export to the National HMIS software (the District Health Information System version 2) effortlessly (Asangansi et al, 2003; Esene, 2015).

One huge limitation again to this study was the observation about the researchers that could cause bias or making the study skewed to one pattern of reasoning, as it was clear during study process that same researchers have been part of study design for project field work and HMIS design inputs from onset (Asangansi et al, 2003; Esene, 2015). This on the other will definitely allow for some form of bias, where the research designers are same evaluators and investigators. It is very impossible not to be drenched in the design or implementation thoughts or even mis-directed to produce findings that are already premeditated with some project expectations due to the involvement.

Also, the fact that the implementers are carrying out this research amongst same staff and participants that already know each other and worked on this same project further increases the bias because the participants might specifically behave in accordance with anticipated findings of the researchers or be very careful not to go against the researchers' observations as observed by studies (Asangansi et al, 2003; Esene, 2015). Their participation, however, might have been intended to achieve the complete realization of project goals by mobilizing stakeholders, engaging them, and ensuring their ownership of the project, but the approach might be wrong as an external researcher or assessor will likely tell the truth or state the obvious more (Asangansi et al, 2003; Esene, 2015). Though, this research has contributed to the understanding that regular training and supervision will improve data quality and produce reliable information for key program decisions as agreed by (UNFPA, 2011).

Key Literature

(Carla AbouZahr et al, 2005) in their publication regarding health information systems; the foundations of public health, examines measurement and public health.

Also, as mentioned earlier in the claims that everything needs measurement to be accepted, that it exists especially in research (Carla AbouZahr et al, 2005). In this study Carla instigated issues around poor foundations of public interventions as it relates to health information systems. (Carla AbouZahr et al, 2005) in research and investigations, queried that there is more reason for not having good health information systems in Africa than just being poor to afford good health information. Still, it could also be that they are poor, but they cannot afford to be without it due to weak data policies. Also, (Heeks, 2011) information systems study focused on health in developing countries and causative factors to failure, success, and local inventions on data storage and usage (Heeks, 2011). This study, in its report, has claimed that many data information systems in developing nations can be classified as either entirely or partially failing (Heeks, 2011). (Carla AbouZahr et al, 2005), in its submission claimed the situation is painfully obvious in the inability of most developing nations to produce the data necessary to track progress towards the SDGs and MDGs (Carla AbouZahr et al, 2005). Consequently, this impacts public health decision-making, which is critically reliant on the timely availability of accurate data (Carla AbouZahr et al, 2005). Furthermore, (Heeks, 2011) contended that the purpose of health information systems is to create, analyze, and distribute such data, yet in practice, health information systems seldom operate systematically, as also concurred by (Carla AbouZahr et al, 2011; Carla AbouZahr et al, 2005).

The purpose of (Heeks, 2011) article, was to examine development of better tangible foundation that engages practical guidance to protect health information failure in the systems and its successes by examining HIS in some data disadvantaged countries (Heeks, 2011). Again, (Mutale et al, 2013) in their submission from the study "*Enhancing health information systems for decision-making in five sub-Saharan African nations*" with an emphasis on executing strategies from the African health initiative (Mutale et al, 2013). Contended why HIS has emerged as one of the acknowledged six essential and interconnected components of a health system; highlighting that a structured and operational HIS should generate dependable and prompt information regarding health determinants, health condition, and health system effectiveness (Mutale et al, 2013). Also, functional systems will have the ability to analyze data to further improve outcomes across all other components of the health system if well utilized (Mutale et al, 2013).

(Yaser et al, 2019), on their research angle; investigated the viewpoint of healthcare providers concerning the difficulties that obstruct the advancement of e-health initiative using the middle east developing country Jordan, in their article: "Challenges to healthcare information systems development" (Yaser et al 2019). This study supports earlier reviewed article by (Mutale et al, 2013), in agreeing that HIS challenges could be as results from steady standard or limited data regulations and policies to assist health systems, financial resources and funding, issues regarding data privacy, also the varied and distinct nature of the Healthcare Sector (Yaser et al, 2019; Mutale et al, 2013).

(Yaser, 2019) concludes that human and cultural issues are most responsible for the challenges of HMIS in less developed countries, however there are other opinions (Yaser et al, 2019). (Archangel, 2007) earlier research had claimed that a deficiency of pertinent

research conducted in nations facing data challenges and regarding the implementation of technologies such as information systems has hindered a lot of progress (Archangel, 2007). Even though (Yaser et al, 2019) still argued heavily that human interference and cultural beliefs still play prominent roles to significantly affect the progress of HMIS in developing nations to guarantee a seamless transition of health services provision (Yaser et al, 2019)

Additional arguments made by studies and research discuss how deficient health HIS pose a significant obstacle to achieving the health-related components of the SDGs, as the performance of health systems cannot be sufficiently assessed when HIS data is either incomplete, inaccurate, or delayed (Measure, 2018; Mutale et al, 2013).

A very important argument on HMIS is key focus on HIS in rising countries with health interventions challenges: benefits, problems, and prospects **(**Salangwa et al, 2025; Mboera et al, 2021). This research article dissected the global health information systems but major focus on data disadvantaged countries, this study expressed how HIS are essential support tools in the administration of health care services provision in both developed and struggling countries (Azubuike & Ehiri, 1999). Again, (Azubuike and Ehiri, 1999) contended that a functional HIS is essential not only for evaluating the health requirements of populations and groups, but also for the planning and execution of health interventions (Azubuike and Ehiri, 1999). (Heeks, 2011), also asserted that a functional HIS allows for decisions at all levels of the health system to be made by identifying progress, issues, and needs to facilitate evidence-based and informed decisions regarding health policies and programs (Heeks, 2011). However, crucially, it is necessary to optimally distribute limited resources to vital elements that contribute to the success of large-scale initiatives that yield health improvements (Heeks, 2011). Nonetheless, a significant factor is noted by (Azubuike

and Ehiri, 1999); claimed that while many advanced nations possess well-established information systems to guide health services planning and delivery, numerous less developed countries have yet to create effective health systems because of inadequate quality data management and information systems (Azubuike and Ehiri, 1999; Heeks, 2011). Therefore, planning and execution of health programs in regions like Africa is conducted by funders who assume interventions can occur without adequate information about the populations and groups utilizing the services (Azubuike and Ehiri, 1999). This complicates Program planning and execution, making it reliant on estimations and conjecture as argued (Azubuike and Ehiri, 1999; Heeks, 2011).

Regional trends on burden of malaria cases and deaths in Africa

Malaria burden as part of diseases in African countries has been a cause of concern in recent decades, the millennium development goals and SDGs have highlighted these in recent years (UN-Sustainable Development Goals [SDGs], 2015). Reducing this burden is a global goal and a burden to all key players in the health space (SDGs, 2015), these challenges necessitate decisions on policy formation, planning, allocation of resources and management of disease prevention and control (SDG, 2015). Agreeing with these challenges expected, it is now essential that choices that are assumed to have the most significant impact on health interventions are made (SDG, 2015; Measure, 2018). However, the focus of this review will be on malaria disease, so that the current malaria situation will be discussed below.

The 2023 WHO World malaria report by Priya Venkatesan, estimated that the number of global malaria cases in 2022 exceeded pre-COVID-19 pandemic levels in 2019, according to (WHO's World malaria report (WMR, 2023). Several threats to the malaria

global response are highlighted in the report, including data use and evident decision making (Venkatesan, 2023).

The report, an annual assessment of global trends in malaria control and elimination, noted that an estimated 249 million cases of malaria occurred in 85 malaria-endemic countries in 2022, a case incidence of 58 per 1000 population risk. For comparison, in 2019 there were an estimated 233 million global cases, a case incidence of 57 per 1000 population at risk. The numbers for 2022 were 55% higher than they should have been if the 2025 Global technical strategy for malaria targets are to be met—an incidence of only 26 cases per 1000 population at risk was expected in 2022 (Venkatesan, 2023).

Of the 249 million cases noted in 2022, 233 million (around 94%) were in the WHO African Region, with Nigeria (27%), the Democratic Republic of the Congo (12%), Uganda (5%), and Mozambique (4%), accounting for nearly 50% of all cases. The largest increase in case numbers from 2021 to 2022 occurred in Pakistan: about 2·6 million cases were noted in 2022 compared with 500 000 cases in 2021. Most of the cases in Pakistan in 2022 emerged after devastating floods occurred in the country between June and October that year, leading to a five-fold increase in caseload. Countries that had not reported indigenous cases for several years, such as Iran, noted more than 1000 cases in 2022 (Venkatesan, 2023).

An estimated 608 000 deaths occurred globally due to malaria in 2022, a mortality rate of 14·3 deaths per 100 000 population at risk. More than 50% of all deaths occurred in just four countries—Nigeria (31%), the Democratic Republic of the Congo (12%), Niger (6%), and Tanzania (4%). Around 70% of the global malaria burden is concentrated in 11 countries: Burkina Faso, Cameroon, the Democratic Republic of Congo, Ghana, India, Mali, Mozambique, Niger, Nigeria, Uganda, and Tanzania (Venkatesan, 2023).

Although, Liberia is not mentioned on the global pandemic map, the (LDHS, 2019) expressed some key challenges in combating malaria in Liberia.

According to another WHO Africa region malaria report presented in 2022, malaria globally still remains one of the major public disease and developmental challenges. there were 249 million malaria cases reported globally and, in this region, inclusive as against 244 million in 2021 having a fractional increase as against expectations of reductions (though with an estimated death of 610,000 globally in 2021 compared to 610,000 in 2022) putting into consideration the donor supports till date, the African region continues to hold a considerable high share of the global malaria burden as highlighted by the world malaria report (WHO Africa region malaria report [ARR], 2022). In 2022, the African region accounted for approximately 94% of all malaria cases and 95% of deaths, resulting in 580,000 malaria fatalities in Africa which represented 95% of all global malaria deaths as indicated by this (WHO-ARR, 2022). Among these fatalities, 67 percent (388,600) were children under the age of five, which amounts to a daily toll of nearly 750 children under age 5 (WHO-ARR, 2022). This makes malaria an urgent public health priority that must be addressed through focused, strategic interventions. (WHO-ARR, 2022).

Again, according to the WHO Africa region malaria report an estimated 2.1 billion malaria cases occurred worldwide (showing there was no malaria decline between 2018 and 2019) and 11.7 million deaths were prevented through strategic interventions between 2000 and 2022 (WHO-ARR, 2022). This report also asserted that the majority of malaria cases (82%) and deaths (94%) averted were located in the WHO Africa region (WHO-ARR, 2022). This report highlighted the primary challenge encountered by African nations in addressing

the malaria endemic as insufficient funding for malaria prevention and treatment services for those at risk of malaria (WHO-ARR, 2022).

This report also highlighted that “Trends in Tanzania” haven to high impact” (HBHI) countries including “Burkina Faso, Cameroon, the Democratic Republic of the Congo, Ghana, India, Mali, Mozambique, Niger, Nigeria, Uganda and the United Republic of Tanzania” have seen their malaria case rates predominantly stabilized in “High Burden to High Impact” (HBHI) categories since the pandemic, and the mortality rate is experiencing a gradual reduction level compared to 2019 figures (WHO-ARR, 2022). This report additionally noted that “11 of the original HBHI countries have 167 million cases (67% of the global total) and 426,000 deaths (73% of the global total), as opposed to 166 million cases and 430,000 deaths in 2021.” (WHO-ARR, 2022). Nonetheless, in the report, the only African nation that succeeded and reported zero malaria cases, which has also sought an official certification of malaria elimination from WHO, was Cape Verde for the fourth consecutive year in 2022 (WHO-ARR, 2022). Further in 2022, the WHO identified around 33 countries as moderate and high transmission countries in this WHO African Region, and the risk statistics breakdown indicated an estimated 35. 4 million pregnant women in Africa, with the malaria-exposed number of these pregnancies amounting to 12. 7 million (36%) at risk of malaria infection during pregnancy (WHO-ARR, 2022).

In another WHO statistics and breakdown according to malaria incidence at subregion, vital information on the prevalence of women exposed to malaria during pregnancy in 2022 was greatest in West Africa at (39. 3%) and Central Africa at (40. 1%),

while it was lower in the East and Southern Africa subregion at twenty-seven percent (27. 0%) (WHO-ARR, 2022).

Compared with other continents and countries like the South-East Asia Region with high malaria cases, this report revealed that this region continued to experience their incidence rate decreasing each year from 17 cases per 1000 population at risk in 2010 to 5 per 1000 in 2018 (70% reduction) in the (WHO global malaria report [WHO-GMR], 2018) In the WHO African Region, case incidence figures also fell from 294 in 2010 to 229 in 2018, indicating a 22% decline. All other WHO regions noted either minimal progress or an increase in incidence rate (WHO-GMR,2018). The WHO Region of the Americas experienced a rise, mainly due to increased malaria transmission in the Bolivarian Republic of Venezuela (WHO-GMR,2018; WHO-ARR, 2022).

In 2018, there were approximately 405 000 deaths from Malaria globally, in comparison to 416 000 estimated deaths in 2017 and 585 000 in 2010. World Bank report. (2018). Children under five years old are the most at-risk group affected by Malaria WHO-ARR, 2022). In 2018, children represented 67% (272,000) of all malaria deaths worldwide (World Bank report [WBR], 2018).

Once more, in referencing malaria comparisons to other continents, the WHO African Region was responsible for 94% of all malaria fatalities in 2018 (WHO-ARR, 2022). Even though this region recorded the most malaria deaths in 2018, it also represented 85% of the 180,000 fewer global malaria fatalities documented in 2018 compared to 2010 (WHO-ARR, 2018; 2022). This indicates that Africa is significantly affected in the battle against

malaria, with nearly 85% of global malaria fatalities in 2018 occurring across 20 countries in the WHO African Region and India (WHO-ARR, 2018; 2022).

Nigeria was responsible for nearly 24% of all global malaria deaths, followed by the Democratic Republic of the Congo (11%), the United Republic of Tanzania (5%), and Angola, Mozambique, and Niger (4% each) at the time of this report and based on the country HIS utilized (WBR, 2018; WHO-ARR, 2022). In a subsequent report, the 2023 WHO world malaria reports revealed that out of the 249 million cases identified in the African region in 2022, 233 million (approximately 94%) were from the sub-Saharan region, with Nigeria (27%), which is an increase from the 2018 world bank and WHO malaria reports, the Democratic Republic of the Congo (12%), Uganda (5%), and Mozambique (4%), accounting for close to 50% of all cases. WHO-ARR, 2022; WHO world malaria report [WMR], (2023). The most significant rise in case numbers from 2021 to 2022 was observed in Pakistan: roughly 2. 6 million cases were recorded in 2022 compared to 500,000 cases in 2021 (WMR, 2023). The majority of cases in Pakistan in 2022 arose following catastrophic floods that occurred in the country between June and October of that year, resulting in a five-fold surge in caseload (WMR, 2023). Nations that had not reported indigenous cases for numerous years, like Iran, recorded over 1,000 cases in 2022 (WMR, 2023).

It was also noted that approximately 608,000 deaths occurred worldwide due to malaria disease in 2022, leading to a mortality rate of 14. 3 deaths per 100,000 population at risk (WHO-ARR, 2022; WMR, 2023). Over 50% of all fatalities occurred in only four nations: Nigeria (31%), the Democratic Republic of the Congo (12%), Niger (6%), and Tanzania (4%) (WHO-ARR, 2022; WMR, 2023). The (WHO-ARR, 2022; WMR, 2023) also

reported that about 70% of the global malaria burden is focused in 11 countries: Burkina Faso, Cameroon, the Democratic Republic of Congo, Ghana, India, Mali, Mozambique, Niger, Nigeria, Uganda, and Tanzania. Even though Liberia is not recorded due to its magnitude of contribution to the world malaria index, The Liberia DHS still describes malaria a grave public health concern in that needs to be focused on (Liberia Demographic Health Survey [LDHS], 2019).

Being a country of 5.2 million population according to the (Liberia Institute of Statistics and Geo-information Service [LISGIS], 2022) data and laden with malaria disease, the WHO figures focused more on countries with heavier populations. However, the United State Government President Malaria Initiative (PMI) in Liberia reported in 2019 that malaria still shows an endemic trend exhibiting an unending Liberia, also that transmission occurs year-round (rainy and dry season) within all geographic areas and communities in the country (United State Government President Malaria Initiative [(PMI] Liberia report, 2019). Liberia has a population of about 5 2 million susceptible to malaria infections according to the (LISGIS, 2022) data; malaria is a significant health disease area in Liberia, with children less than five and pregnant women being at risk or the most affected groups (PMI, 2019; LISGIS, 2022). The (Health Facility Survey [HFS], 2018) of Liberia national report also emphasized on how malaria has become or remains the primary cause of illness and death in the community, representing 34% of all outpatient visits and 48% of inpatient admissions (HFS, 2018). This report also highlighted those children aged five and below account for 35% of all malaria cases and 34% of inpatient fatalities; this scenario has not significantly changed according to the WHO Africa region report on malaria (HFS, 2018; WHO-ARR,

2022). The (Liberia Malaria Indicator Survey [LMIS] 2022), which follows the 2009, 2011, and 2016 LMIS surveys, provides a current estimate of essential demographic and health indicators related to malaria in its report (LMIS, 2022). Also confirmed this recent data, which indicated that malaria is a significant public health issue in Liberia, noting that 34% stem from outpatient visits, while 47% originate from inpatient services as documented, and 23% of hospital deaths as previously reported by the Health Facility Survey of 2018 (LMIS, 2022; HFS, 2018). This is expected to follow from the belief that the National Malaria Control Program (NMCP) current execution of its fourth (National Strategic Plan [NSP], 2021–2025) will enhance the previously mentioned statistics, with the primary objective of the plan being to decrease the malaria burden by 75% by 2025 (NSP, 2021–2025; LMIS, 2022).

Furthermore, the 2022 malaria indicator survey (MIS) indicated that the prevalence of malaria (determined by the Malaria Rapid Diagnostic Test) was 45% in children aged 6-59 months, with regional differences ranging from 12% in Greater Monrovia to 69% in the South-Eastern B region, which encompasses River Gee, Grand Kru, and Maryland (LMIS, 2022; PMI. (2022).

In Liberia, even though public sector intervention has shown how reported data gathered from its health facilities has suggested a decline in malaria using the earlier trend before 2018, they were considered to be of lower quality in data gathering (Kunimitsu, 2009; PSAC, 2018). Especially seeing the trend from 2010 to 2019 according to the World Bank report on the ITNs ownership. However, the (LDHS, 2019; 2020) has shown improvement with the new trend up to 62% from the LMIS 2016 but recorded a drop during the most recent (LDHS, 2019; 2020). Hence, it becomes essential as malaria interventions improve to

also strengthen country's information system and provide high-quality data for further planning (Richard et al, 2015). To attain this, malaria surveillance systems based on six sentinel health facilities are conceptualized, and setup HMN, including planning, should be emphasized (Richard et al, 2015). The idea is to surround this health system in current existing structures that could increase the likelihood of long-term sustainability and report data through the existing HIS structures using existing information system tools (HMN, 2005).

On the other hand, malaria outbreaks or epidemics may follow years of low incidence and thus low immunity in the population (Mutale et al, 2013). In either case, "new" intervention resolutions that are effective with different approaches made to further curb this disease endemic of high transmission would be required, and these decisions would need to be informed by high-quality data (HMN, 2005). (Mutale et al, 2013) study argued on weak HIS structures and systems, which could challenge ongoing efforts on achieving health-related SDGs as expected (Mutale et al, 2013). This argument is based on measuring health systems and its performance on health systems and disease intervention that becomes challenging to assessed causing some parts of HIS data to become inadequate, wrong, or late to be reported.

This has arguably informed an urgent need for appropriate, consistent, and correct data-based decision through an informed HMIS that is mostly critical in malaria control in Liberia (Measure, 2012). This means that the absence of a deliberate HMIS that supports critical decision-making for planning will continue to jeopardize the health system. The

biggest challenge is that figures generated from countries with weak information systems still affect data and planning (Dehnavieh, 2018).

Theoretical/Conceptual Framework

Theoretical Framework

Introduction

Nenonen & Nylander contend that over the past decade, many nations and international organizations have established health information systems (HIS) (Nylander & Nenonen, 2002). In their article "A theoretical framework for health information systems" (Nylander & Nenonen, 2002). This study in agreement with Nenonen & Nylander used this theoretical framework to show that data cannot always be assumed to be accurate or decisive and that even cutting-edge methods do not guarantee a reliable outcome for planning, hence the need to delve into “HMIS and decision making in developing countries”. The issue with data appears to be related to its use and management; it also includes the desire to build a complete system with several components and how health information systems' components enhance disease interventions and policies. Measure. (2018). On the other hand, there have been numerous occasions when even the most basic steps, such as gathering and refining data into indicators, have only resulted in perplexity when these indicators have been employed in healthcare planning and management at both the local and national levels (Nylander & Nenonen, 2002).

The theoretical framework of an HIS is made up of several parts, much like the system itself (Nylander & Nenonen, 2002). The discussion in this study begins with more tangible topics, such as the use of information from the system to the "disease control strategies" and potential organizational tiers for utilizing quality information (Nylander & Nenonen, 2002). The discussion

then moves on to the idea of a knowledge of data demand and theories in application or use. In conclusion, it connects all of these concepts with organizational management ideas and disease interventions (Nylander & Nenonen, 2002).

The organizational levels of using data

Public health experts are increasingly utilizing the information in their clinical databases to assess the effectiveness, cost, efficiency, and completeness of their work in contemporary HMIS or HIS applications (Achoki & Lesogo, 2016; Mboera, 2021). This becomes especially crucial if health care professionals are said to have population responsibility for their patients and this necessitates the use of epidemiological background data, active follow-up of chronic illnesses, and other measures (Esene, 2015; Mboera, 2021). The emphasis at the local level is on the efficient and cost-effective delivery and provision of services because for instance, the data are still connected to specific patient's diseases and utilized to recognize and improve the services used by 'community population' or patient groups (Esene, 2015; Mboera, 2021). However, more administrative data are utilized for things like benchmarking (benchmarking government and non-governmental organizations, benchmarking communities and primary clinics) (Nylander & Nenonen, 2002; Esene, 2015; Mboera, 2021). In Liberia, for instance, data implementation planning and policy development are conducted at the national and regional levels, with the majority of applications being administrative at the regional level (DQIP, 2022 – 2027). The emphasis here is on service networks and promoting the idea of seamless care, and so the information system is subjected to high demands at the national level due to the calls for equality, efficiency, safety, and quality, as well as the creation of the national health plan (Measure, 2018; DQIP, 2022 – 2027). Due to financial weariness, the function of international organizations may

decline in the future as shown already, hence it is anticipated that reliance on international donors will be lessened and governments planning for ownership should increase (Measure, 2018; Salangwa. 2025; DQIP, 2022 – 2027).

In the realm of statistics, the constraints of data and information for making decisions have been acknowledged for many years (such as metadata) (Measure, 2018; Salangwa. 2025; DQIP, 2022 – 2027, Nylander & Nenonen, 2002). To address this challenge, various systems have been developed to offer essential context for comprehending the data or information, which typically include details about how the data was gathered, definitions of different variables, and the extent of data completeness with use, among other things (Measure, 2018; Salangwa. 2025; DQIP, 2022 – 2027, Nylander & Nenonen, 2002). This type of information is referred to as 'metadata'—essentially data about data giving information on other data (Nylander and Nenonen, 2002). Nonetheless, this notion has also been muddled with similar, confusing definitions, much like the term 'knowledge,' as pointed out by (Nylander and Nenonen, 2002). For some individuals, metadata refers solely to information that is directly associated with the actual data elements, while for others, it encompasses an understanding of how the national healthcare system operates through the use of data to understand information; and this is what this study of information use tends to demonstrate (Nylander and Nenonen, 2002).

Linking theories to a health information system model

The application of these theories enables one to simplify the process of developing a Health Information System into different phases of understanding and implementations (Measure, 2018). This is, of course, a very basic outlined process where it is not advisable for programs to begin the development of HIS based solely on the intervention guidance and used before but based on

futuristic data use (Nylander and Nenonen, 2002; Measure, 2018). These phases comprise a lengthy journey involving extensive reading, reflection, understanding and discussions with both national and international experts and colleagues on diseases as done in the Liberia health systems (DQIP, 2027; Nylander and Nenonen, 2002).

The development of HIS commences with pinpointing a position on the "disease control strategies" (Nylander and Nenonen, 2002; Measure, 2018). It is essential to understand where the component we intend to create fits; for example, a strategic reporting framework for in-patient services won't just meet the epidemiological requirements for type II diabetes or severe malaria, nor can a system focus on outpatient statistics function as an alert mechanism for all disease control (Nylander and Nenonen, 2002; Measure, 2018).

Additionally, we must determine possible data sources, consider data security factors, and recognize which systems can benefit from shared data (Nylander and Nenonen, 2002; Measure, 2018).

Also, to specify the data requirements and their level of detail, it is important to utilize a knowledge hierarchy alongside a data utilization matrix so we can ascertain what is required at each tier (Nylander and Nenonen, 2002; Measure, 2018). Different health conditions have unique information demands: for instance, when respondents visit a doctor for a common cold, a total count may suffice (Nylander and Nenonen, 2002; Measure, 2018). However, for other national diseases, we need comprehensive information on the entire service episode, which includes both occurrences and treatment care, along with laboratory resource usage. Nylander and Nenonen. (2002). As we move to higher tiers, the information becomes progressively more structured and coded, while the significance of meta-levels increases (Nylander and Nenonen, 2002; Measure, 2018).

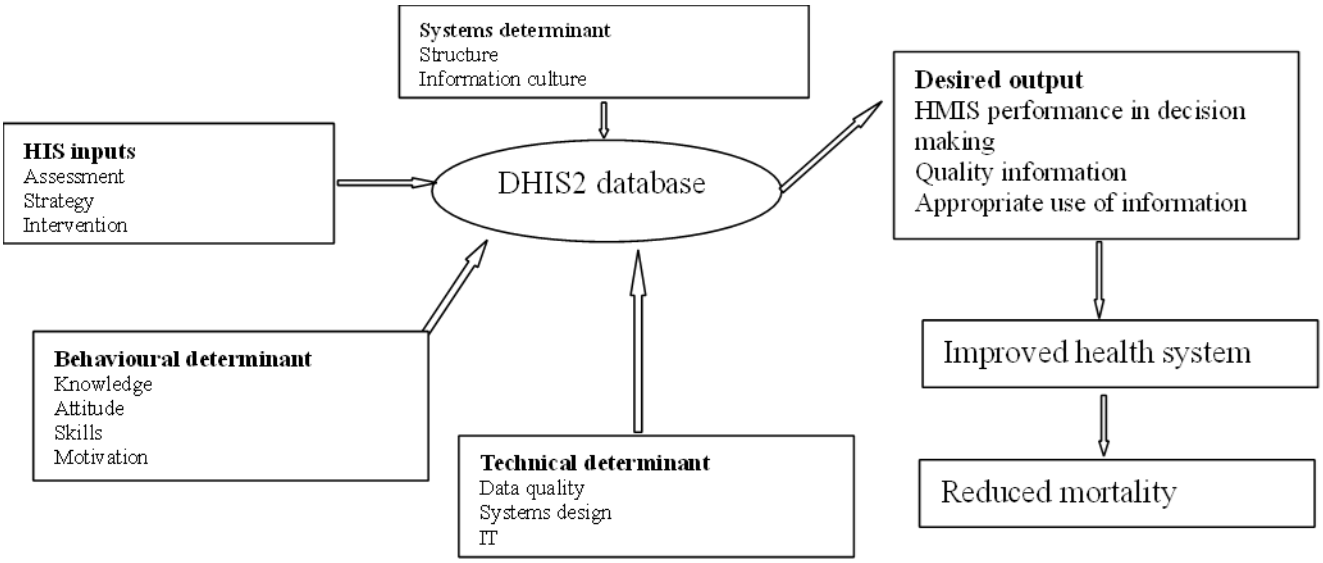
Conceptual Framework

The challenges surrounding data demand and use in the developing world has been termed as a global issue and exploring the theoretical reasoning behind the use of HIS, its importance to health interventions/control and how it relates to functional health systems in Africa (especially Liberia Malaria interventions) to gain knowledge of the phenomenon is this research focus. in examining the relationship between Health Information System (HMIS), decision-making and planning in developing countries, significantly, how it affects the capability of the health management information system to generate high-quality program data to determine intervention, control, transformation and performance from key data outcomes and results (MEASURE, 2019).

It is important to examine the generation of quality data for decision making and to understand more fully the successes and challenges to data demand and use, how it contributes to the national and global health interventions. This study examines each of the phases or steps taken on data to have key understanding of their impacts on health systems. This theoretical framework will provide a background in the Health Information Management Systems and its uses, which will help to explain some of the actions that either hinder or encourage information for strategizing and choices (MEASURE, 2019).

Figure 1

Conceptual Framework



Background of study

Problem

The Data Quality Improvement Plan evaluation documents distinctly highlighted the strengths and difficulties within Liberia's Health Information System (HIS) context; a significant volume of healthcare data is collected and available, yet it faces major obstacles such as HMIS tools and HR. Nevertheless, the data remain fragmented across various facilities throughout the nation (LDHS, 2019; DQIP, 2022 – 2027). The (LDHS, 2019; DQIP, 2022 – 2027) have reported clear HMIS central roles and structures, being domiciled at the MOH as the coordination arm. However, due to the aforementioned challenges of tools, HR and definite structure the data demand and use have directly or indirectly resulted in the underutilization of the available data that affects

key decision making. There, making decisions that are not evidence-based affects healthcare planning and service delivery to the communities and the country.

United Nations states that in most developing countries, including Liberia, social and economic development is hindered due to a lack of information and information systems, especially within health systems for decision-making and planning (UN-MDG, 2010). This study will be conducted to resolve the identified challenges. Developing a framework or methodology to guide data management for planning toward improved services within the Liberia healthcare facilities.

Purpose

This research in its study tends or aims to understand the evolution and functionality of data use to inform health interventions in the system, country's HIS structure and its role in decision-making related to health planning, and policy formation especially malaria prevention and control in Liberia.

The Liberia National Demographic Health Survey (LDHS, 2013) reported that malaria related morbidity and mortality declined for three years consecutively. However, the (LDHS, 2019) reported a decline in ITN ownership which is the main strategy for reducing mortality rate in malaria. Even though the earlier report of the (LDHS, 2013) was an excellent development, data collection and data quality were problematic because of processes and systemic errors as reported by the (DQIP, 2022). It is now apparent that decision-making information with the most significant impact on healthcare and disease control must be in place. However, this will depend mainly on Liberia's good and effective health management information systems and structure to be decided by the national implementation (Malaria national framework [NSP], 2021– 2025).

Therefore, a common starting point will be developing and strengthening health information systems at a country level to provide high-quality primary data with health facilities as a critical source of such data (HNM, 2005). The second will strengthen the national capacity to synthesize, analyze, interpret, and use the data in the given country's context (Kunimitsu, 2009). Hence, the framework will expound on the information system regarding structure and data use to achieve clear research significance.

Significance of study

This study will tend to provide evidence on two key points such as.

1) Reasons why health management information systems and evidence-based decision making remain weak, and

2) How these gaps can be strengthened sustainably in Liberia as a part of developing countries to further improve health systems and reduce mortality rates through evidence-based planning and interventions.

Health System and Information Management (Structure and Data)

In understanding the Liberia health system, malaria control program is coordinated by the Ministry of Health (MOH) through donor-supported programs and interventions in the 15 counties with 93 health districts and communities. Malaria interventions are the widest and most common intervention that is implemented in all facilities (both government and private owned facilities), and diagnosis could be Microscopy (Lab) and Rapid Diagnostic Test (RDT) (LMIS, 2022). Rapid Diagnostic Test could be at the facilities or community levels, including private organizations such as pharmacies as clearly described in Liberia National Demographic Health Survey (LDHS, 2019; LMIS, 2022).

In this study, malaria data are generated from different sources and facilities in Liberia, including consultation, hospital diagnoses, rapid community testing, etc. Through teaching hospitals, secondary health facilities, primary healthcare centers and communities (Liberia National Health policy and strategy [LNHPS], 2018 – 2023; (National Health Plan [NHP], 2022-2031).

Within the Liberia healthcare sector and the Malaria control, data is mostly generated and collated using forms which is the source documents that are utilized to document information at community and facility tiers, either structured or unstructured (DQIP, 2022). Looking at the structured aspect, data is collected and classified according to report significance that guides decision at various levels of healthcare services (DQIP, 2022; Iyamu & Mgudlwa, 2018). This was critical because some data use situations are considered more serious during implementations and important to track than others, such as data that determine mortality and morbidity rate in Africa as agreed with Iyamu & Mgudlwa argument. (DQIP, 2022; Iyamu & Mgudlwa, 2018). (DQIP, 2022; Iyamu & Mgudlwa, 2018) again in their arguments had explained why data in its necessities are employed and its usefulness in managing interventions via choices made by both technical and human agents (Iyamu & Mgudlwa, 2018). The utilization of health data expertise in this type of research is primarily influenced or dictated by the presence of effective resources, the presence of critical and skilled personnel, comprehension of protocols, and an analysis of data concerning demand and utilization (MEASURE, 2019).

In assessing HMIS for decision making in Liberia, using malaria control programs and intervention, this study depends on a division between structure and information use (Data). They count on and influence each other toward healthcare systems building (Luthuli and Kalusopa, 2018). The theoretical framework methodology will now be discussed in the next section.

Methodological Approach

A case study design with a structured tool design using a mixed-method approach will be used to engage the respondents. This will help the research triangulate information through influential data culture of best practice. Data will be collected at health facilities, regional health facilities and the main data collection levels at the Ministry of Health through document analysis, survey, in-depth interviews of key informants, direct participation, and direct observation of practices. Qualitative data will be collected to answer research questions related to "How the HMIS was developed and has evolved in the past five years? "and "How reliable and appropriate the malaria HMIS data for malaria control decision-making has been?" "What determines the supporting factors to effective HMIS strengthening for malaria control in the country?" and "How the use of HMIS data has supported planning in malaria prevention and control?" While both numeric and descriptive data will be utilized to address the research question. " How reliable and appropriate HMIS data for malaria control decision making has been?"

The proposed study data process is divided into two components. This will help attain generalization of the outcome. In the first component, the standard of data produced by the essential sentinel health facilities will be examined, and high-standard policy-relevant data will be identified in an ongoing manner. In the second component, this data will be presented to decision-makers and used to explore how evidence is perceived and used to (a) further strengthen the health information system and (b) inform decisions about malaria control in an ongoing manner over three years.

Component 1

This consists of two parts and is designed to provide information on malaria data quality. In the first part, data extracted from the outpatient and laboratory registers at the six sentinel sites will be assessed to identify policy-relevant data such as the burden of malaria, diagnostic procedures and treatment practices. The HMIS reporting tools will also be reviewed to assess the degree to which they collect policy-relevant data that is identified.

In the second part, a cross-sectional observational study will be carried out to determine the quality of documented and published data. The research will determine any significant difference in the malaria slide positivity rates among those suspected of malaria that the clinical staff sends for testing compared to those not sent for testing. This would enable an appreciation of the impact of the diagnostic methods used by health workers on the epidemiological profile of malaria observed at the health facilities and the quality of the data produced, as indicated by (Kunimitsu, 2009).

Component 2

In this part, the data generated under component 1 will be presented to decision-makers and used to explore how evidence is perceived and used to (a) further strengthen the health information system and (b) Inform decisions about malaria control. The data will be presented through oral presentations and written reports and include actionable recommendations. The use of this information will then be observed in real-time through direct observation/participation. Document review and key informant interviews will also be undertaken to understand further how and why decisions were made or why a decision was not made (non-decision). Potential vital informants will be those most likely to be involved in or responsible for decision making.

They will be drawn from the National Malaria Control Programme, HMIS Programme, Directorate of Health Services, Directorate of Planning and Information, Regional Directorates of Health Services and the Country Office of WHO.

Research design and methodology

The research process and the philosophies involved.

This study adopts a systematic research approach and philosophical outlines that will engage the HMIS structures along with other essential data to generate trustworthy reports and suggestions. In its design, the study will employ a nonexperimental and mixed research approach due to the strength of clarifying the nature and intentions of the research (Bryman, 2006).

Most importantly, the research study will attempt to gain knowledge of the health information systems phenomenon through a critical review (literature); this research draws some essential understanding and findings of health system data management from key desk review of some current and existing documents and articles that focuses on data and information use to explore the connection between HMIS and decision-making in developing nations. Primarily how it influences the capability of the health management information system to produce high-quality program data to determine intervention transformation and performance from data results (Al Zefeiti & Mohamad, 2015). This phenomenon is significant to understanding the influence of HIS as it relates to what is recognized as true (epistemology) in contrast to what is thought to be true (doxology) in data gathering, analysis and use in critical program decision making from a different context (Al Zefeiti & Mohamad, 2015).

To achieve the research objectives, key and suitable data collection tools and processes are adopted after the sampling techniques have been agreed upon to ascertain what facilities and staff will be engaged.

Considering that qualitative and quantitative research approaches enhance findings' integrity, as Bryman (2006), argued. that a combination of qualitative and quantitative research methods is utilized here to gather and analyze quality data. Additionally, qualitative research seeks to investigate and depict the phenomenon, while quantitative research will engage description and explanation in the research (Al Zefeiti & Mohamad, 2015; Bryman, 2006).

Also, while the quantitative method in this research investigated the relationship between data capture, usage and decision-making, the qualitative approach examines issues linked to the functions and activities of the healthcare personnel and systems participating in the HIS (Al Zefeiti & Mohamad, 2015; Bryman, 2006). Quantitative designs also addressed sample size, including data types collected, sampling engaged, data gathering techniques, data handling and evaluation strategies. Meanwhile, qualitative research data gathering utilizes interviews, focus groups, and dialogue analysis. (Al Zefeiti & Mohamad, 2015; Bryman, 2006).

Further, many significant variables of interest in this research were not meant to be manipulated, mainly because data epistemology is of more importance to addressing global health planning (Johnson, 2001).

Therefore, this research engaged a mix of purposive, stratified and random sampling methods for participants' selection at the health facilities to be interviewed and surveyed; the target population for this research will consist of individuals engaged in or accountable for decision making within the essential high-level ministries and counties, record, monitoring and evaluation

staff of each health facility across selected facilities from the 15 counties in Liberia (Coughlan et al, 2007).

Data collection tools

Data collection method and tools

The methods for data collection will involve a mixed-method approach (qualitative and quantitative) utilizing a prepared or structured questionnaire template to collect critical quantitative data from vital health ministry and facilities staff. Key informants' interview with participant observers that include FGDs will be employed for the qualitative approach that will help produce key statistic elements for analysis in the research (Coughlan et al, 2007).

While the qualitative data collection process involved conducting an IDI interview and FGDs that featured case studies with ethnographic observations, (Krauss, 2005); the quantitative data gathering was carried out using a well-defined structured questionnaire to address research questions and comprehend processes within the health systems (Kunimitsu, 2009). The data collection process depended on historical data spanning four years or more as questions arose to help identify policy-relevant data such as the burden of malaria, diagnostic procedures, and treatment practices (Kunimitsu, 2009).

Data was collected at health facilities, regional and central levels across all the 15 counties in the country using techniques and tools that capture in-depth data as mentioned above, including interviews, Focused Group Discussions, questionnaires, Observations and Documentation to gather real-time information. In this research, the data collection process included both the researcher's presence and research assistants because of the nature of the country's data storage on the HMIS that must be extracted.

The qualitative approach was engaged in the Liberia health information system research investigations because of its ability to achieve a natural and valuable understanding of the research phenomenon needed for first-hand information, as demonstrated by (Hussey and Hussey, 1997; Alexander, 2002).

That is an intelligent design and approach that will look at achieving a genuine and valuable understanding and context characteristics through observing from an objective point of reality in the study (Hussey and Hussey, 1997; Alexander, 2002).

Due to limited funds, the study engaged probability and non-probability (purposive) sampling methods in selecting sample sizes from respondents and facilities involved in the Liberia health system (did not engage the whole health facilities).

Possible Analyses to Be Adopted

Data analysis

Quantitative data will be analyzed using the Statistical Package SPSS or software Stata/IC 11.0 and the analysis will be presented in descriptive table and graphs for interpretations, qualitative data will be coded and transcribed with analysis presented on cloud format. Content and critical interpretative analyses will be used for qualitative data. The qualitative analyses will be enriched by applying social theory, such as the structuration theory by (Anthony, 1984).

This study engaged NVIVO qualitative analysis software because of its ability to analyze extensive data, including unstructured text, audio, images, video data from interviews, FGD, etc. However, manual coding was used for a small amount of data gathered that should not be ruled out at some levels.

Since this study depends on a large amount of information and was time-consuming in its data collection process, it relies on NVIVO, which accommodates and analyses extensive data. Further, NVIVO has the strength of analyzing précised words from individuals and groups of the same roots such as primary facilities, districts, counties and country levels in deriving meanings to the study. Lofgren. (2013). It was also engaged in analyzing other forms of qualitative data collection such as observation scripts and FGDs audio tapes that will be fully transcribed as much as possible to make extracts for analysis, transcriptions and theme usage was engaged with respondents' information using manual coding because of the small amount of data in a narrative format to achieve a clear understanding of the nations' HMIS frameworks (Ho, 2006).

However, in the latter part of the study that engages quantitative data, SPSS and Stata/IC 11.0 will analyze data; questionnaires were coded and categorized for entry into the SPSS for data analysis and to produce real-time information for this research, data editing was conducted to be sure questionnaires are correctly filled and ensure data quality (Anthony, 1984).

So, Quantitative data was engaged with SPSS and Stata/IC 11.0 to produce a real-time result for this research because of its ability to handle extensive data and perform rigorous analysis. At the same time, qualitative data did not only engage NVIVO but was also transcribed and coded. The structuration theory will be engaged by applying social theory to enrich the qualitative result (Anthony, 1984).

These data analyses will be descriptive and inferential statistics approaches; this will help the research study find a steady pattern.

Reporting

The research will produce a manuscript for journal articles with their findings and not more than 30 pages. The report will concentrate on reporting critical aspects of the results related to health management information systems and decision-making. The report will not be published except with the consent of the ministry of health in Liberia. However, the ministry can decide what will be done with the report aside from political reasons.

Results

An Overview of The Results of The Research

The WHO in a 2012 report described the HMIS structure and operation in Africa to producing one time data for planning as a huge challenge in not achieving the intended results, making choices and strategizing in the health sector extremely challenging, particularly in fighting diseases such as malaria (WHO report, 2012). Therefore, a convincing and operational framework for assessing health system performance is vital for the work of governance, government, development agencies, and multilateral institutions (WHO report, 2012; HNM, 2005).

In Liberia, dependable and data-driven decision-making becomes essential in the health system, especially in malaria control (LDHS, 2013; 2019; DQIP, 2022 -2027). To address these data challenges and combat subsequent health challenges, the first step will be to enhance the HMIS at the national level to deliver high-quality data through health facilities as significant sources of data collection (DQIP, 2022 -2027). The alternate method emphasizes enhancing the national capability to gather, analyze, interpret, and utilize the data for making decisions in the given country's health context (DQIP, 2022 -2027).

The apparent consequence indicated by the DQIP of this data challenge becomes the ability of the health system to improve on the quality of in-country data to base contextually relevant decisions that will contribute to planning and improving the health system (DQIP, 2022 -2027).

This study aims to establish an understanding between quality data and functionality of the country's HMIS and its purpose of making key planning decisions regarding Liberia's malaria programme and control. Also, to explore the reasons affecting the ability of the HMIS processes to generate high-quality malaria-related data in malaria programming.

A Discussion of The Results and Their Implications

This research, in its results, aims to offer a collection of insights into the reasons why health management information systems and data driven evidence decisions are made continually to be ineffective and how they can be sustainably improved in developing nations to enhance the health system and decrease mortality rates via evidence-based strategies.

This research result will be presented to decision-makers and used to explore or recommend how evidence is perceived and used to further strengthen the health information system and (b) inform decisions about malaria control that will further reduce mortality rate and improve population health stability.

Conclusion

Healthcare services worldwide are meant to be delicate services provided to citizens by their government through structured health facilities. Therefore, with the limited resources in developing countries, it is best to make crucial decisions that are likely to have the most significant impact on individual health (UN-MDG, 2008). Hence, it is clear that poor healthcare service delivery can result in loss and damage lives (UN-MDG, 2008). Then, the purpose of any healthcare facility is to provide quality services to its patients (UN-MDG, 2008). However, the largest obstacle continues to be the inadequate HMIS in Liberia that obstructs the planning and objectives of attaining quality services (LDHS, 2013; 2019; DQIP, 2022 -2027). Therefore, the research

utilized duality of systems' structure and information used to recommend quality outcomes for planning.

In recent years, research and studies have indicated that it is not solely due to the poverty of developing countries that they are unable to finance effective health information systems, but rather that these countries have yet to grasp the significance of proper information systems as outlined by (AbouZahr et al, 2005). Some other developing countries can genuinely not afford the funding of a sound health information system; however, no matter how poor a country is, it cannot afford to be without a strengthened health information system. Researchers have shown quality studies and examples of countries' systems with information for evidence-based decision-making resulting in enhanced health planning and interventions (AbouZahr et al, 2005). These national examples must be broadened and increased through additional research to facilitate better information and data for essential decision-making. Consequently, the moment has arrived to dedicate significant effort and resources to constructing health information systems that proficiently assist public health and global population (WHO report, 2012).

This study, in its conclusion, tends to answer the primary research questions and achieve the research objectives set before it with the purpose to develop an understanding of the development and operation of the health information system and its function in decision-making related to health planning, especially malaria prevention and control in Liberia.

To attain this conclusion, the study developed a basic research design phenomenon, a competing design and a framework that increases health information system insight. This design employed a mixed-method or research approach (qualitative and quantitative) and triangulation with other existing documents. This has helped the research improve its findings and recommendations.

In addition, the assessment of qualitative data primarily disclosed harmonious findings with quantitative analyses while adding some distinctive insights in terms of cultural similarity, trust and commitment among health facility staff and population. In this analysis, cultural similarity regarding health services and confidence in data is evident with some support from the health facilities.

This thesis signifies the usefulness of these theories/research in the understanding 'of the evolution and functionality of the health information system and its role in decision-making and the importance of Health Management Information Systems as a remarkable endeavor in global public health systems (But most especially developing countries and Liberia as a focus.

Further, the system will produce a reliable result to engage the health system and produce highly reliable recommendations that allow for critical decision-making.

Summary

Human development has been one of the most discussed in information and lack of information systems; efforts are being made globally to curb this menace, especially by the United Nations (UN) agencies (UN-SDG, 2015).

In Africa, the Health Information System (HIS) has been an enormous challenge that makes decision-making and planning in the health sector very difficult, especially in combating diseases like Malaria or curtailing the burden (WHO report, 2000; 2017). If this burden is to be reduced, then a critical decision on planning, allocation of resources, policies for controlling diseases, contributions, and prevention is essential, considering the limited resources in Africa.

In the Liberia context of Health Information System, the DQIP and the Malaria indicator survey has claimed that data management in Liberia has been faced with several challenges

including incomplete, inconsistent, and late or incomplete reports as observed from communities, Health facilities, Districts, Counties and National level (DQIP, 2022 -2027; LMIS, 2022). And it is asserted that a significant quantity of healthcare data that is collected may not be documented or actually exist, but they are intentionally and unintentionally dispersed in fragments throughout facilities within the nation (DQIP, 2022 -2027). This has led to some challenges at the central HMIS structure and the issue of data demand and use that directly or indirectly somewhat led to the insufficient use of data, which impacts healthcare planning and service provision to the communities and nation (Measure, 2018).

In agreement with the United Nations claims that in most developing countries including Liberia, social and economic development is being hindered due to lack of information and information systems but most especially with health systems for decision making and planning UN-MDG 2000; SDG, 2015). This study is being conducted based on the identified challenges, making it essential to create a framework or methodology that can direct how data may be organized for planning to enhance services within the healthcare facilities in Liberia as a primary goal.

Purpose

This study aims to cultivate an understanding around the development and operation of a country's health information system and its significance to decision-making. related to health planning, especially malaria prevention and control in Liberia.

(DQIP, 2022 -2027) highlighted some gaps in the HIS data processes and use. It highlighted that the Liberia HIS is marked by regular postponements in the deployment and distribution of standardized data tools, as these practices could lead to delay in reporting and cause some data transcription errors DQIP, 2022 -2027). The Liberia Data Quality Improvement Plan –

(DQIP) Further indicated that the existing data flow system at both community and health facility levels is hindered by service interruptions due to shortages of essential data tools and necessary logistics for data collection for reporting, thus impacting report adequacy (DQIP, 2022 -2027) Additionally, the Data Quality Improvement Plan stressed the limited capacity of human resources, both in quantity and quality, to capture, record, and interpret data undermines data availability (DQIP, 2022 -2027).

The Liberia Data Quality Improvement Plan –(DQIP), in the report further assessed the HR components and effectiveness of data processes (DQIP, 2022 -2027). The report stated that data used at both community and health facility levels are being short-lived or distorted by limited HR capacity in data use to inform decisions, coupled with poor feedback from upper levels on program performance (DQIP, 2022 -2027). It is now very clear that decision making information with the greatest impact on healthcare and disease control must be in place, however this will depend largely on good and effective health management information systems in Liberia (LMIS, 2022; DQIP, 2022 -2027).

Therefore, in any structure that develops its information system, a common starting point will be to develop and strengthen the health information systems at country level to provide high quality primary data with health facilities as a key source of such data. Health Metrics Network by (WHO, 2005). The second will focus on strengthening national capacity to synthesize, analyze, interpret and use the data in the given country context (Kunimitsu, 2009). Hence, the framework will expatiate on the information system as regards structure and data use to achieve clear research significance.

Significance of study

This study result and recommendation will be tasked to provide a body of knowledge on why health management information systems and evidence-based decision making remain weak and how they can be strengthened sustainably in developing countries (Liberia) to improved health system and reduce mortality rate through evidence-based planning and interventions.

Decision rule

Healthcare services worldwide are meant or should be designed to offer intentional services to citizens by their governments, through organized health facilities (SDG, 2015; UN-MDG, 2010). Therefore, with the limited resources in developing countries it is best that significant choices are determined that are likely to have the most substantial influence on personal health (UN-MDG, 2008). Hence, since it is evident that inadequate healthcare service delivery can lead to loss and/or harm to lives; consequently, the aim of any healthcare institution is to deliver quality services to its patients (SDG, 2015; UN-MDG, 2010). Nonetheless, the primary challenge continues to be the deficient Health Information Management Systems in Liberia, which obstructs the planning and objectives of attaining quality services (LDHS, 2022). Thus, the study employed duality of structure and information use to recommend quality outcomes for planning.

This study also reviewed the health management information systems structures that Human resource (HR), equipment and some other key factors may affect planning. The report outlined some key findings using the Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis. Nevertheless, one of the key concerns that was made clear in the report was the limited supplies of equipment that affect the health information systems in its management, such as computers, their peripherals and IT applications to enhance data administration efficiently (DQIP, 2022 – 2027).

The study review also identified some other key areas of weakness from the (DQIP, 2022 – 2027) report, which include limited human resources (HR) regarding personnel capacity for data management in support of the data flow system, especially at the subnational levels, such as counties and primary health facilities (DQIP, 2022 – 2027). Additionally, one of the most significant findings from the report was the Delayed and insufficient data reporting caused by a shortage of health management information systems tools at some health facilities, especially at the community health care facility levels (DQIP, 2022 – 2027). Such a challenge if not properly and frequently attended as recommended by the DQIP Further, the report emphasized the absence of assistance from the usual oversight, evaluation, and guidance of personnel operating on the health management information system corridors on data was a key gap among others (DQIP, 2022 – 2027). The private sector was also noted to face a significant challenge regarding their utilization of obsolete data tools; all these problems and other difficulties were acknowledged to represent major hindrances that impact data availability, data quality, and data utilization for planning and decision-making (DQIP, 2022 – 2027).

Health Information System (HIS) structure and Data Use in Liberia

Again, just as the World Health Organization conveyed the necessity for development countries to curbing population diseases through attaining high-quality data that address health challenges; these area of discuss in various country's disease areas has been a massive challenge of the health sector in Africa especially in decision making (WHO, 2018). In the case of Liberia and its health Information system management, it was seen that data utilization at both community and healthcare facility levels is very much in progress but sometimes the data flow is hampered by limited human resource capacity as also indicate by

the (DQIP, 2022 – 2027). This key gap has a significant effect on the data flow and analysis and using data to inform decision, this study from the In-depth interviews also found out some gaps with mentoring or supervision paired with inadequate responses from higher management regarding program effectiveness that should have informed improvements at health facilities. In support of these findings, the (DQIP, 2022 – 2027) reported the absence of or no capacity development framework or an effective merit-based system for advancement, promotion, and acknowledgement of employee performance within the health system, and this causes some staff to have a poor attitude towards the data system of the country (DQIP, 2022 – 2027).

The health information system management strengthening structure was not readily available or sighted at the time of this study, however the (DQIP, 2022 - 2027) reported the lack of standard supervisory checklist that identifies some strengths and weaknesses related to staff and system efficiency at every tier that encompasses primary, secondary, and tertiary facilities (DQIP, 2022 – 2027). In a separate report highlighting the necessity for personnel and resources to bolster the health information systems and data utilization, the (Liberia Data Quality Report [DQR], 2021) stated that there were certain difficulties at the district level (given that 80% of the malaria data comes from the health districts) such as insufficient ability to compile summary reports and charts. The report further underscored the absence of tools, equipment, supplies, and a framework or format that includes a well-coordinated peer review at the sub-national level, which enhances decisions related to data use as part of key challenges (DQR, 2021; DQIP, 2022 – 2027).

CHAPTER 3: RESEARCH METHOD

Introduction

This chapter centers on HMIS and decision making in developing nations. (still a focus on Liberia) With a study on the burden of disease claimed to be most significant in developing countries (Africa, mainly hit), as declared by the World Health Organization [WHO], 2000) report. Reducing this burden is a global goal of the (UN-MDG, 2000; SDGs, 2015), requiring decisions on policy, planning, resource allocation, and disease prevention and control management. Given the limited resources in developing countries, decisions that are expected to have the most substantial effect on health, considering the available resources, must be made (Kasambara, 2016).

(Kasambara, 2016) also highlighted the necessity for reports that are precise, pertinent, and current, which have essentially become one of the most vital indices or indicators for an effective or efficient health system and its structure and planning (Kasambara, 2016). The structures of health information systems can only be as robust as intended if they are well captured from the district; this is why health information systems are said to require significant support for data flow from the district to the national level as correctly described by (Koumamba et al, 2021). This consequently implies the necessity and significance of having a very strong and effective data structure, supported by the District Health Offices (DHO) and the Ministry of Health (MoH), for proper and efficient data collection and transfer, as well as for monitoring health services and population status for accurate analysis (Koumamba et al, 2021). This procedure will consequently assist in the provision of services to communities with effective health accountability; this health information process also aids in the coverage of additional health services and trend measurements, including health utility transfer and management, drug stocks and consumption patterns, equipment status and availability, finances, and how health personnel are overseen for data

collection or regular reporting (Karuri et al, 2014). (Karuri et al, 2014) further stressed the importance of producing timely and accurate data from various district health facility sources, which is crucial for healthcare services and decision makers, so that the health managers and decision makers at both community and Ministry of Health levels can identify weaknesses in health care service provision or data flow and take the necessary actions to improve service delivery and health information (Koumamba et al, 2021). It was stated that a good or efficient Health Management Information System (HMIS) is a process that facilitates data flow, where health data (input to HMIS forms) is recorded with frequent availability, stored in a database, retrieved when necessary, and processed for decision-making following key data analysis (Koumamba et al, 2021).

In data demand and its utilizations as outlined by measure evaluation in 2018, decision-making in health or disease interventions primarily involves stakeholders and managerial elements such as planning, policy development, and oversight of health care services in facilities at national, state, district, or community levels, along with clinical (both private and public) aspects that recognize the importance of delivering essential and optimal health care services to the population (Measure, 2018; Kasambara, 2016). The HMIS in Liberia has been in existence for about 14 years but still has some challenges with data quality as recorded by the Data Quality Improvement Plan, however due to some improvement to generating data and reports from 91% of the health district facilities; some decisions have been made that supports malaria interventions (DQIP, 2022; LMIS, 2022). Although the country still requires support to improve its quest for reliable and accurate data, which is hindered by certain improper use or unavailability of HMIS tools at the facility level, or accessible information in the planning and management of health services that is missing in some locations (DQIP, 2022 – 2027; Kasambara, 2016; Koumamba et al, 2021).

In 2013, after the Ebola crisis in Liberia that caused a very huge gap in the health system, the Ministry of Health initiated efforts to enhance the health systems and health management information system by analyzing the strengths and weaknesses of the current information systems and distributing the findings to all stakeholders. that has led to an organized HMIS system with a coordinating unit as described by multiple sources and articles (Kasambara, 2016; NSF, 2021–2025; NSP, 2021–2025; DQIP, 2022). The stakeholders and health managers recognized a requirement for reforming various critical and rapid response interventions along with program-specific data or information systems that will ultimately result in a comprehensive, integrated, decentralised, and action-oriented simple system for planning and policy development (Kasambara, 2016; NSP, 2021–2025). Central to this system and methodology was the transition to digital form, from the previous paper system that was cumbersome to use and generate reports from, and the issues related to insufficient reporting or incomplete reports from private clinics and hospitals (Kasambara, 2016; Alwan et al, 2016; DQIP, 2022).

The Liberia (DQIP, 2022) stated that the developed Health Management Information System and its structures was accepted and adopted for use nationwide but with not up to 60% of staff trained for implementation at the primary healthcare centers at the district level (DQIP, 2022). Even though the system has been operational for approximately 14 years, it still faces various data and information issues mostly at the community level, which can be attributed to several factors including insufficient training and unavailability of HMIS tools that affect accurate and timely reporting (Kasambara, 2016; DQIP, 2022; Koumamba et al, 2021).

Many scholars, including (Azubuike and Ehiri, 1999) agree globally that the Health Information system can provide numerous benefits because accurate and timely health intervention coverage has been a significant cornerstone of public health practice (Azubuike & Ehiri, 1999). If

properly addressed, it will lead to increased health accountability and enable bodies to enhance the capability to track advancement toward global, national, and sub-national aims and objectives (Azubuike & Ehiri, 1999; Dehnavieh. et al, 2018). Quality information through an improved data collection process is essential to recognizing strategic modifications necessary to fulfill obligations for significant health-related decision-making, as described by a WHO report in June 2015. If well attended to, this whole thinking and process on information systems could offer solid and trustworthy information as the basis of decision-making across all health system components, which is crucial for health system policy formulation and execution (Measure, 2019; Azubuike & Ehiri, 1999).

In most developing countries, social and economic development is hindered due to a lack of information and information systems, especially health systems, for decision-making and planning (UN-MDGs, 2015). The (WHO, 2015) report has characterized the health information and its management systems operating in Africa as a significant challenge, complicating decision-making and planning within the health sector, particularly in the fight against diseases and malaria inclusive (WHO, 2015).

In Africa, HMIS and its structure have been an enormous challenge that makes decision-making and planning in the health sector very difficult to attain, especially in combating diseases like malaria (WHO, 2015). To reduce this burden, a critical decision on planning, allocation of resources, and policies for controlling disease contributions and prevention are essential, given the limited resources in Africa.

To address these data challenges, the first step will be to develop and strengthen health information systems at the country level that will support and provide high-quality data through health facilities as a significant source of data collection. The second approach from this study will

strengthen the national capacity to collect, analyze, interpret, and use the data to make decisions in the given country context.

Statement of the Problem

The massive challenge in Africa is the need for evidence-based decision-making from quality data that promotes the nation's sectorial planning and building, mainly focusing on the health system that leads to access to good health. This is now very critical, and more attention is beginning to be paid in developing countries as mentioned by the SDGs, focusing on Liberia, the need for reliable data and evidence-based information system that reduces mortality in the health sector, especially in malaria control is most essential and needed as demonstrated by the survey (LDHS, 2019). The critical factor to planning and access to health as globally recognized is the capability to gather, assess, interpret, and apply data for making decisions as acknowledged in a Measure Evaluation assessment report of 2019 (Measure, 2019). Likewise, critical decisions that are significant to health access and address existing challenges would require high-quality data for the Liberia health system.

Purpose of the Study, Research Aims, and Objectives

This research has employed a mixed-methods study approach and techniques to triangulate with the aims of developing an understanding of the evolution and functionality of the health management information system and its significance in decision-making concerning health interventions, specifically regarding malaria prevention and control in Liberia.

The research objectives are to offer sound and dependable information as the basis for decision-making across all health system building blocks, which will be accomplished through two primary goals: 1. Investigating the factors influencing the capacity of the health management information system to produce high-quality malaria-related data. And 2. Examining the challenges

that impact systemic decision-making and planning associated with malaria prevention and control in Liberia utilizing the health management information system.

Additionally, to investigate and analyze the factors influencing the capacity of the health management information system to produce high-quality malaria-related data. And to examine decision-making associated with malaria prevention and control.

Research Method

This study in its systematic research approach and philosophical outlines that engaged the health information system for malaria of the Liberia ministry of health to generate dependable reports and suggestions. In its design, the study employed a nonexperimental and mixed research approach due to the strength of clarifying nature and intentions of the research (Bryman, 2006).

The proposed Health Management Information System (HMIS) study with its set hypothesis relied on a mixed method approach (quantitative and qualitative) using an observation, secondary data and case study design with structured tools to engage the respondents; this becomes appropriate because using quantitative method allows broader respondents to be contacted (Earl, 2010).

Research Approach and Design

This research study explores the evolution and functionality of health information, its management, system and its role in making relevant decisions in the health system of Liberia. The study will have two key focuses. The first focus was strengthening health information systems at a country level and providing high-quality primary data with health facilities as a critical data source. The second focus is supporting the national capacity to synthesize, analyse, interpret, and use the data in the given country's context. This study was designed using a mixed method approach that will look at not only the quantitative data characteristics but also objective reality,

using qualitative to attain natural and valuable insight into the research (Hussey and Hussey, 1997; Alexander, 2002). One significant focus of the research study is to recommend the integration of improved data collection systems from the findings into existing structures to increase the likelihood of long-term sustainability, and to report data through the existing HMIS designs using existing HIS tools. And the most appropriate approach will be to consider the systemic process of enquiring about data and information through strategically developed data collection tools (Alhadeff-Jones, 2013).

Aim of the study

This study in its intentions aims to understand the evolution and functionality of the health management information system and its role in decision-making related to malaria prevention and control in Liberia.

Objectives

1. To investigate the difficulties impacting the health management information system in order to produce reliable and high-quality data

2. to explore the challenges hindering the systemic decision-making and planning using quality data as related to disease prevention and control in Liberia.

Research questions

Q1. How has the health management information system developed and has evolved in the past five years?

Q2. How appropriate is the malaria HMIS data for malaria control decision-making?

Q3. How has the use of HMIS data supported planning in malaria prevention and control?

Q4. What are the expected determinants to effective HMIS strengthening for malaria control in the country?

Methodological Approach and Design

This study adopted a systematic research approach and philosophical outlines that engage the malaria health information and data capturing system, its system and management by Liberia ministry of health to produce reliable reports and recommendations. In its design, the study employed a nonexperimental and mixed research approach due to the strength of clarifying nature and intentions of the research through its objectives and hypothesis as stated (Bryman, 2006).

The proposed Health Management Information System (HMIS) study with its set the hypothesis in the research depended on a combined method approach (quantitative and qualitative) utilizing an ethnography/observation. and case study design with a structured tool to engage the respondents; this becomes appropriate because using the quantitative method allows broader respondents to be contacted (Earl, 2010). And quantitative approach will provide participants with some level of freedom (e.g., observation and interview) that permits naturalness, which will help reveal some individual issues and outliers that allow the global representation of the results (Adami & Kiger, 2005; Thurmond, 2001). This will also help the study to triangulate information through influential data culture of best practice.

The primary purpose of triangulation in this study is to avoid any contradiction between these methods but instead focus on its sense of the possibilities of bringing techniques together to improve and shed light on any chosen social research study (Olsen, 2004). The triangulation approach will contribute to the overall quality of the research and to the extent that it facilitates the achievement of some articulated purpose" (Adami & Kiger, 2005).

The primary triangulation method depended on methodological triangulation, mixing qualitative and quantitative methods that allow a holistic representation of global view in research analysis (Casey & Murphy, 2009; Adami & Kiger, 2005). And expresses how quantitative data

can enhance studies by revealing outliers or unique individual cases of the study context (Adami & Kiger, 2005).

Samples and samplings

Quantitative

Studies clearly state a good assumption that is of utmost importance behind quantitative research that data source and sample size could be a very clear representation of the targeted population if carefully used and appropriately implemented; hence this becomes acceptable because all individuals within the targeted population (health data clerks, M&E officers and officers in-charge) possess a recognized likelihood of being chosen for the sample (Onwuegbuzie & Collins, 2017). The resulting sample size of 15 percent for health facilities and data staff meets the power criterion to detect statistically significant relationships and differences between population object and assumptions of this study, as agreed and described by Onwuegbuzie & Collins in their article (Onwuegbuzie & Collins, 2017). This design used a simple random and stratified sampling scheme to select a representative sample for this study from all 15 counties, where all primary, secondary, and tertiary facilities have the same probability of being selected for this study. Also, all data staff of these facilities had same opportunities to be elected and a designed structured questionnaire for responses was used to collect qualitative questionnaires to understand the evolvement and uses of data for disease planning in Liberia MOH using the malaria intervention.

The Liberia health district is 93 with 923 facilities that reports through the DHIS2 including secondary and tertiary facilities, the sample of 138 HFs (out of 923 available health facilities for selected) was drawn from these 15 counties, 93 health districts using a calculated 15% sample for the quantitative to further improve on the accuracy of reports using 95% confidence Intervals (C

I) that supports the integrity on generalization. 128 participants were selected but 124 participated in the study out of the estimated sample frame of 850 data officers and M&E officers, though the whole estimated participants were 1,072 (with community health workers under MoH) from which 161 study participants were engaged (124 data clerks, nurses, officers in charge, doctors, M&E officers, etc. and 37 community health workers).

However, the qualitative might differ and might take a sample beyond 15% since the senior officers do not have such a large population in the country. And so, this research will tend to increase the respondents for qualitative data as the case arises.

Qualitative

The samples for this study were intentionally selected using more purposive or purposeful sampling techniques for the counties and this is due to the understanding that all the health facilities and staff are already known to be randomly selected from, hence this means that the research already knows the key population to be addressed and sampled from as respondents. The study in addition, then identify sub-categories of a specific group to ensure that certain groups are included in the sample (Onwuegbuzie & Collins, 2017).

This sampling process engaged respondents through critical informants' interviews with designed instruments, direct participation, observations, and document review.

Mixed method

The mixed method approach in this study thus represents a continuous and holistic process. This process will be continuous, continuous in the survey means each stage will proceed from previous steps’ outcomes and flow directly into the next phase (Onwuegbuzie & Collins, 2017).

Alternate methods for this research as utilized by (Esene, 2015; Casey & Murphy, 2009) would have been a quantitative method or approach in research using only questionnaires; this will

enable a designed questionnaire to be distributed to reach more respondents, but the challenge will be the number of limited respondents. Further, this method of data collection will be limited from getting clear understanding of the current data demand and use situation because due to fear of exposing data trend in the country, responses might be minimal. Hence, this study focused on getting firsthand understanding on how data supports planning in Liberia health sector used a focused group discussion and face-to-face interviews.

Data collection

Study design

A mixed method and cross-sectional analytical study design was utilized in data collection taken from sampled population (as presented in the table below), analyzed through to findings of this study. This process went beyond the fundamental ratios of conveying the 'who', 'where', and 'when' in the study and looked at the relationship between the potential evidence factors (the 'how' and 'why') that affects malaria information and planning for interventions outcome itself (Esene, 2015). The study examined the connection between predictor variables (the respondents' work experience) and outcome variables (their understanding of HMIS and its uses), this supports health staff in finding these connections, which may then be investigated in more detail through cohort studies and randomized controlled trials by other researchers (Esene, 2015).

Table 2

Health Districts and Facilities

Districts Health	Health facilities at the districts	Districts Health	Health facilities at the districts
Commonwealth Central Monrovia	A Place of Rescue Health Clinic The Good Will Clinic Annex 2	Dowein Cavalla	Beh Town Clinic Beh Town Clinic (Cavalla)

Somalia Drive	Aaron Wildal Med. Lab Clinic	Leewehpea Mah	Beindin Clinic
Somalia Drive	ABC Clinic	Trenbo	Behwah HEALTH CENTER
Central Monrovia	ACFI Medical Clinic	Zota	Belefanai Health Center
Somalia Drive	ACRES Clinic	Sanoyea	Beletanda Clinic
St. Paul River	AF Russell Clinic	Central	Belle Blama Clinic
Jorquelleh	Africa Fundamental Baptist	Monrovia	Bellemu Clinic
Somalia Drive	Mission Clinic	Panta	Karnga Clinic
Somalia Drive	Africa International Med. Clinic	Garwula	King Joy Comm Clinic
Suakoko	AFRO-Medical Communiy Clinic	Gola konneh	Bengee Clinic
Sanniquellie-Mah	Agape Clinic	Commonwealth	Benlysia Clinic
Commonwealth	Agape Clinic	Sanniquellie-	Beo-Yoolar Clinic
Bushrod	Agape Health Clinic	Mah	Benson Hospital
Central Monrovia	Ahmaddiya Muslim mission	Twa River	Bensonville Hospital
Senjeh	Clinic	Commonwealth	Besoa Clinic
Sanniquellie-Mah	Ahmaddiya Muslim Mission	District #1	Bishop Darlington Clinic
Central Monrovia	Clinic	Klay	Bishop John Collins Clinic
Careysburg	Ahmaddiya Clinic	District #10	Blamacee Clinic
Commonwealth	Air-Field Community Clinic	District 15	Blamo Town Community
Bushrod	Albert Medical Clinic	District 17	clinic
Commonwealth	Albino Society	District #15	Blessing Home Maternity
Commonwealth	Alfred F. Kortio Medical	District 5	Clinic
Central Monrovia	Al-halal Medical Clinic	Somalia Drive	Blessing Home Maternity
St. Paul River	All Grace Medical Clinic	Porkpa	Clinic
Central Monrovia	All Health Care Clinic	Central	Kongo Mano River Clinic
St. Paul River	AME Clinic	Monrovia	Boakia Clinic
Bushrod	Amusawyer Clinic	Doedain	Bodowhea Clinic
Bushrod	Angel Midical Clinic	District #3 A&B	Boeglay Town Clinic
Central Monrovia	Angel way women center Clinic	Doedain	Boegeezay Clinic
Somalia Drive	Antah Clinic	Owensgrove	Bokay Town Clinic
Jorquelleh	Anthony Medical Clinic	Garr Bain	Bomah Clinic
Yarmein	Anty Gloria Medical Clinic	Kolahun	Bolahun Health Center
District 17	Ar Nur (The light) clinic	Tewor	Bo Water Side Clinic
Sanquin #2	Ark of Noah	Voinjama	Bondi Clinic
Kokoyah	Arcelor Mittal Hospital	District #4	Bong Community Clinic
Zoe Gbao	Arthington Clinic	Karluway 2	Boniken Clinic
Zorzor	B O P Clinc	Fuamah	Bong Medical Hospital
Voinjama	Bah-ta Clinic	Dowein	Bonjeh Town Clinic
Gola konneh	Bahn health center	Boe & Quilla	Bonlay Clinic
Bopolu	Balagwalazu Clinic	Gibi	Booker Washington
Garwula	Balakpalasu Clinic	Zorzor	Institute Clinic
District 17	Varguaye Clinic	Kokoyah	Borkeza Clinic
Gibi	Bambuta Clinic	Konobo	Botota Clinic
Commonwealth	Bendu Community Clinic	Panta	
Barclayville	Banjor Community Clinic	Marshall	
Cavalla	Barbour Hill Community Clinic		

Voinjama	Barconnie Clinic	Yarwin	Boundary Clinic
Pleebo	Barclayville health center	Mehnsonnoh	Boway Clinic
District 11	Bargblor Clinic	Somalia Drive	Boye Town Clinic
District #3 A&B	Barkedu Clinic	District #10	Boyee Clinic
Zorzor	Barraken Clinic	District #1	BRAC Diagnostic
Voinjama	Barnersville Health Center	District 17	Laboratory Clinic
Buu - Yao	Barseegiah Clinic	District 2	Breath of Life
Senjeh	Barziwen Clinic	Mehnpea Mah	Breath of Life Clinic
Dowein	Bazagizia Clinic	Gee	Bromely Community Clinic
District 8	Beadatuo Clinic	District #13	Brown Community Clinic
District #6	Beafine Community Clinic	Butaw	Bunadin Clinic
District #1	Capital Medical Clinic	Buu - Yao	Buah HEALTH CENTER
Harper	Carever Mission Clinic	Buu - Yao	Bushrod Island
Pleebo	Careysburg Clinic	District #1	Community Clinic
District 17	Cavalla Clinic	Jorquelleh	Butaw Clinic
District #4	Cavalla Rubber Plantation	Commonwealth	Buutuo Clinic
District 14	Medical Center		Buutuo ULIC Clinic
Commonwealth	Cedar Medical Center		Camp Sandee Ware Clinic
District 9	Ceegbah Clinic		Camp Tubman Military
Fen-River	Cemenco Clinic		Clinic
Gibi	Censil Medical		Camphor Mission Clinic
Jorquelleh	Central Matadi Dweh Memorial		
Marshall	Clinic		
Cabada	Charlie's Town Clinic		
karforh	CH Rennie Hospital		
Central Monrovia	Charles B Dunbar Hospital		
Bopolu	Charlseville Clinic		
Commonwealth	Chebioh's Town Clinic		
District 5	Cheboken Clinic		
Tchien	Children Clinic		
Somalia Drive	Chief Jallahlon Hospital		
Commonwealth	Chrisnah Clinic		
Central Monrovia	Chocolate City health center		
Gibi	Christ the King Clinic		
	Christain International Clinic		
	Christian Extension Ministry		
	Clinic		
	Chugbor Clinic		
	Cinta Community Clinic		
	Community clinic		

This table is provided by the malaria programme of ministry of health (NMCP – MOH, 2023)

Pretest

A pilot cross-sectional survey was conducted prior to the field work where qualitative and quantitative data was collected through in-depth interviews, documentation review and focus group discussions. Study participants comprised of 10 HMIS Officers, 10 data officers and 10 District Health Managers, from 10 health districts in the Monrovia district on Montserrado. The pretest study was conducted 2 months before the field work and the data collected was checked for uniformity and error, then transcribed to identify key theme and key points in preparation for the field work, tools adjustments were made where necessary to further provide clarity and intention to achieve the objectives. Such as in (Esene, 2015).

The tools utilized for data collection in this research study predominantly came from a mixed approach. (qualitative and quantitative approaches questionnaire and interview tool); the tools from these approaches are appropriate because qualitative research allowed richer answers to questions put to respondents by the researcher and give some valuable insights that might have been missed by any quantitative method (Morse, 1991). Furthermore, the reason being that some key characteristics and natural occurrence amongst variables are essential in this research (Alexander, 2002).

Data was collected at health facilities that includes regional and central levels (national malaria program at the ministry of health) across all the 15 counties in the country using techniques that include document review, survey, in-depth interview of key informants, direct participation, and direct observation of practices.

Qualitative data were collected to respond to research questions such as: "How the HMIS developed and has evolved in the past four years? "and "How reliable and appropriate the malaria HMIS data for malaria control decision-making has been?" "What determines the supporting

factors to effective HMIS strengthening for malaria control in the country?" and "How has the use of HMIS data supported planning in malaria prevention and control?" While both quantitative and qualitative data will be used to answer research questions relating to "How reliable and appropriate is HMIS data for malaria control decision-making has been?"

The proposed research approaches are designed to offer details on the quality of malaria data (Research Questions) and are separated into two sections. In the initial section, quantitative data were gathered from the outpatient including laboratory registers at the six sentinel sites and using structured checklists and rating scales known as Likert scales to rate data availability (Leedy and Ormrod, 2005). This data was collected from five years; this process identified policy-relevant data such as the burden of malaria, diagnostic procedures, and treatment practices (Kunimitsu, 2009). Further, structured in-depth interview tools were developed (both face-faced and telephone - in the case of non-availability of some key respondents) for the key informants such as government personnel and implementation agencies. In this research, the data collection was more on both the researcher's presence and research assistants because of the nature of the country’s data storage on the HMIS that must be extracted. Also, a structured questionnaire template was designed to collect critical quantitative data from key health ministry staff to help produce key statistical elements for analysis in the research (Coughlan, 2007)

In the second part, a cross-sectional observational study using the observation and participation method for data collection was conducted to ascertain the quality of recorded and reported data. A participant-observer approach was employed for this part of the research; a covert method was intentionally used because the data collection and validation were not carried out at one point, and ethical considerations were necessary.

This process is critical because it does determine if there is any significant difference in the malaria slide positivity rates among those suspected of having malaria that the clinical staff sends for testing compared to those not sent for testing. Furthermore, a qualitative interview tool with a few questions was developed for in-depth understanding of the research, recorded discussions with senior ministry staff and a focused group discussion with a subset of the junior team, including data clerks, field data collectors, HMIS county staff, and HMIS central staff. This data collection process has helped to gather and allow key characteristics and natural occurrences amongst variables needed in this research (objectives 2 & 3) (Alexander, 2002).

In this second part of this component, key informant interviews and document reviews were also used to gather further information about historical antecedents and functionality of the HMIS. In addition to the key information above, individuals who formerly occupied senior positions in the Ministry of Health would be identified and approached.

Finally, in this data collection process, the potential key informants were those most likely to be involved in or responsible for decision-making from the key ministries. They were drawn from the National Malaria Control Programme, HMIS Programme, Directorate of Health Services, Directorate of Planning and Information, Regional Directorates of Health Services, and the Country Office of World Health Organization (WHO).

The proposed study data process is divided into two phases. This in turn supports the research to attain a generalization of the outcome.

This phase consists of two parts and is designed to provide information on malaria data quality. In the first part, data extracted from the outpatient and laboratory registers at the six sentinel sites will be assessed to identify policy-relevant data such as the burden of malaria,

diagnostic procedures, and treatment practices. The HMIS reporting tools will also be reviewed to determine how much they capture the identified policy-relevant data.

In the second part, a cross-sectional observational study was conducted to ascertain the quality of recorded and reported data. The study will determine any significant difference in the malaria slide positivity rates among those suspected of malaria that the clinical staff sends for testing compared to those not sent for testing. This would facilitate an understanding of how the diagnostic methods used by health workers impact the epidemiologic profile of malaria observed in health facilities and the quality of the data produced, as indicated by Kunimitsu in his study article (Kunimitsu, 2009).

In this phase, the data generated under the first phase will be presented to decision-makers to explore how evidence is perceived and used to (a) further strengthen the health information system and (b) Inform decisions about malaria control. The data will be presented through oral presentations and written reports and include actionable recommendations. The use of this information will then be observed in real-time through direct observation/participation. Document review and key informant interviews will also be undertaken to understand further how and why decisions were made or were not made (non-decision). Potential vital informants will most likely be involved in or responsible for decision-making (Coughlan, 2007). They will be drawn from the National Malaria Control Programme, HMIS Programme, Directorate of Health Services, Directorate of Planning and Information, Regional Directorates of Health Services, and the Country Office of the World Health Organization as much as available.

Data analysis

Quantitative data was analyzed using SPSS to produce accurate time information for this research. Qualitative data was transcribed and coded, and content and critical interpretative

analyses were engaged to further explain key qualitative data features. Applying social theory, such as the structuration theory by (Anthony, 1984).

However, there was some data preparation in the quantitative to convert raw data into meaningful information before the proper analysis. That included a data validation process to see if the data was collected according to pre-set standards, data editing was also engaged to be sure questionnaires are correctly filled in, and data coding, which includes assigning values to responses was conducted. These data analyses were descriptive as will be discussed below and took an inferential statistic approaches to clearer discussion; this has helped the research study to find and maintain a steady pattern (Onwuegbuzie & Collins, 2017).

Qualitative analysis in this study started as soon as the data became available; this was totally different from the quantitative method, which is well planned out. This data collection method was mainly a face-to-face interview, FGDs, observation and more exploratory research; a framework was developed for coding observations, as it involves ideas, concepts, etc.

Coding

Qualitative raw data excerpts were extracted according to importance using memos (field notes) to bring together key codes into themes and topics applying codes automatically and the results were presented in clouds format. The qualitative analysis steps involved data import where files were imported, codes (nodes) were created before coding. Further, codes were applied to data using an auto coding system in the NVIVO before reviewing and analyzing results.

Quantitative data engaged the SPSS for analysis, again the data was coded according to data description; variables were created and data entered using the 5 years HMIS malaria data for analysis. Then, results were created in tables and graphs presentations.

Researchers from different fields frequently utilize both qualitative and quantitative research methods and approaches for their studies to attain logical results that can be generalized (Onwuegbuzie & Collins, 2017). So, the mixed research method might be more productive and prosperous in the depth of results (Onwuegbuzie & Collins, 2017).

Population and Sample of the Research Study

Population

This research investigated the structural use of HMIS by utilizing the HMIS data entry tools and forms to link with the national District Health Information System (DHIS2) data instance at the central level. The primary research emphasis was placed on personnel involved in the malaria intervention at the Ministry of Health and the data entry staff in health facilities across the country.

Since the research drew on a mixed research design, a probability and non-probability sampling technique allowed us to make statistical inferences (i.e., generalizations) from our sample of HFs information and DHIS2 data.

The study populations are the malaria intervention program of the ministry of health (MOH) in Liberia; this will also include the malaria programme key staff and other HMIS data staff of the church of Health. The potential participants will all be either data officer/M&E officers or record staff of primary, secondary and tertiary health facilities in Liberia and MOH staff as indicated earlier. The research will identify such officers as mentioned above at the randomly selected facilities for the study. The research participants will be automatically selected by being the data/M&E officers of the designated facilities for the study.

All participants will be well informed and sensitized beforehand to make a voluntary decision. However, the ministry or malaria program director will choose other participants from the national level because they are either the custodians of the health data or in the data-capturing processes.

The sampling strategy is chosen probability and non-probability sampling

The specific sampling technique used: purposive sampling.

This research design used a simple random and purposive sampling scheme to select a representative sample for this study. The target population was malaria staff of the MOH (that included field officers such as nurses, community workers of health and volunteers at some point) and data entry clerks/officers of health facilities from all 15 counties and 93 districts of health in Liberia. Also, all data staff of these facilities can be selected and use the designed structured face-to-face and hand-administered questionnaire for responses. This tends to understand the evolution and functionality of the HMIS and its role in decision-making related to malaria prevention. The measurement unit focuses on routine malaria data that is gathered and entered into the District Health Information Systems (DHIS2) database for the nation.

Sampling frame

The HMIS data on DHIS2 is a countrywide database for malaria so the quantitative analysis will depend on the national data from 2015 to 2020 on the DHIS2 platform. This is a purposive sample population to be used in this research. Further, the study draws another reference from desk review using documents and analysis from county data and information, including written research and examinations.

The qualitative data will draw a sample from the population of 923 health facilities (HFs) from 93 health districts in 15 counties of the country, with approximately 850 HIS officer/M&E/data entry staff (this study regards data entry staff to be the officer in-charge of data regardless of the nomenclature, any staff why enters data will be interviewed) at health facilities (including Tertiary, secondary and primary). A random sample of 15% is drawn for the health facilities to have 138 HFs and estimated 128 data staff recruited for the study responses.

The research study aims to illustrate a direct correlation between the size of the target population and the number of individuals to be incorporated in the sample, and therefore the study aims to utilize a sample with an acceptable precision level for the examination of the event (sample error) and the confidence level of this outcome (typically 95%) (Sekaran and Bougie's, 2016). 15% sample is engaged with the research markings for better population representation and generalization reasons (Sekaran and Bougie's, 2016). This Sekaran and Bougie's article also highlighted that as the precision increases (smaller sample error) and the confidence level rises (in this instance, 95% was taken into account for all calculations), the necessary size will also be greater than the initial 10% deemed appropriate for a population of less than 10,000 (Sekaran and Bougie's, 2016). This research will maintain the significance level (95%) and the design effect (1. 0) unchanged throughout the study, and a manual sample calculation will be engaged due to the sample that is less than 1,000 (Sekaran and Bougie's, 2016).

Liberia has Fifteen Counties and 93 Health Districts (Ministry of Health [MOH] report, 2022). In the aforementioned country, there are Eight-Hundred and fifty-six (856) functional health facilities according to the data quality improvement plan 2022 (document)

out of 923 (HMIS facility data) on the DHIS2 platform. submitting services delivery report through DHIS2 and Nine Hundred & Sixty-Four (994) on the Master Facility Listing (MOH, 2022; DQIP, 2022 – 2027; LDHS, 2019).

The quantitative information for examinations will be obtained from DHIS2 for the time frame of January 2015 to December 2020; however, data from January 2021 to December 2022 will also be examined as the study advances.

Table 3

Population and Sample Selection for Study

Item	Existing number (population)	Sample selected
Counties	15	15
Health districts	93	14
Health facilities	923 (880 opened for selection)	138 HFs (15% of 923 were selected)
Data clerks/HIS officers/M&E officers, etc.	Estimated 850 1,072 (with community health workers under MoH)	128 (124 participated) 161

This table provides the study sample frame that includes the sample (participants) selections from the population of study.

Criteria for selection

The data entry staff regardless of the terminology met at the facility and who actually enters data into the HMIS tools is regarded as the data officer for this study. Also, the study will engage these data staff who have more than one year’s experience due to the expected knowledge in data collection, entry and use.

Sampling Techniques

The study employed a non-experimental and mixed research approach (qualitative and quantitative) due to the strength of clarifying the nature and intentions of the research. Bryman.

(2006). The study sampling also used a probability (simple random) and nonprobability (purposive) sampling method.

Since the dissertation research population is already known by the (malaria department of the ministry of health and the HF data entry staff), a non-probability purposive sample is used to select the sample. Then a probability sample (simple random sample) is used to choose HFs and participants for the study.

Data quality and checks

This consists of two parts and is designed to provide information on malaria data quality. In the first part, data extracted from the outpatient and laboratory registers at the six sentinel sites will be assessed to identify policy-relevant data such as the burden of malaria (the data here is just for quality check because they are already entered into the DHIS2 platform), diagnostic procedures and treatment practices. The HMIS reporting tools will also be reviewed to determine how much they capture the identified policy-relevant data.

In the second part, a cross-sectional observational study will be carried out to determine the quality of documented and reported data. The study will determine any significant difference in the malaria slide positivity rates among those suspected of malaria that the clinical staff sends for testing compared to those not sent for testing. This would allow for an understanding of the impact of the diagnostic methods used by health workers

on the epidemiological characteristics of malaria observed at the health facilities and the quality of the data produced, as indicated in (Kunimitsu, 2009).

Sample selection

Identifying with Esene in the healthcare facility studies, a multistage sampling method composed of three stages was likewise employed to choose the facilities and healthcare personnel that took part in this study (Esene, 2015).

This sampling technique as explained earlier involved engaging a nonprobability purposive sampling on the selected counties, but A straightforward (simple) random sample was utilized to choose the facilities and staff from the health district as noted below.

Stage 1: Selection of counties and health District Areas.

Liberia has 15 counties 93 health districts and 923 health facilities to be selected from, a comprehensive list of all the counties, admin districts, health districts and health facilities that constitute the country's health systems was obtained from ministry of health HR data. In addition, the national malaria programme staffing, and controlled facilities were selected to further complete the sampling to be selected from for the research. The 15 counties were selected purposively considering that the study was conducted in all these counties, these selections followed a process of sampling health districts from each county through a simple random sampling technique. This technique engaged a table of all HF numbered as objects to be selected and was done ensuring representativeness of same criteria but bearing in mind the existing three types of settlements (urban, sub-urban and rural)

including the hard-to-reach areas (it's good to note that malaria is the widest implemented disease in the country).

Montserrado Monrovia being the largest and most populated county in Liberia had the highest health districts and reporting health facilities (398 health facilities out of 923), 43% of the health facilities were open and selected for sampling during this process while the other counties accounted for the rest 57% opened for sampling selection. In engaging these health facilities, The WHO requirement of 25% coverage for health facilities in any health assessments, particularly studies that involve primary health care assessment as the subject of utilization, was fulfilled (Esene, 2015; Macfarlane et al, 1997; UNICEF, 1991). The health districts selection was also carried out through a simple random selection and followed by the sampling of health facilities as described earlier from all the counties namely: Montserrado, Margibi, Bong, Maryland, Nimba, Bomi, Sinoe, Grand Bassa, Grand Kru, Grand Gedeh, Lofa, Grand Cape Mount, Gbarpolu, River Cess and River Gee.

Stage 2: **Selection of health facilities.**

In the second stage, which spells or describes the health facility selection. Even though the study dependent on only the government facilities referring to the public owned health institutions, this study enquired and engaged currently updated HF reporting list for the country both government (public) primary health care facilities and private owned facilities (clinics, hospitals, pharmacies treating malaria) were obtained from each of these 15 counties and selected health district areas was obtained from the MOH and malaria programme. This study is grounded in the determined minimum sample size of 138 public primary health care facilities for this research (bearing in mind that the private health

facilities were omitted do to reporting lapses as reported by the country's (DQIP, 2022), also a careful comparative size that is representative of all health districts and primary health care at counties were put into considerations and selected in each of the 93 health districts. This process of sampling processes is done because the study has put in consideration total population of reported health facilities by MOH (in the health district) and considering the health districts with a very few health facilities (e.g., River Gee with just 2%), making the number of HF under this study to be determined easily from each of these selected 14 health districts.

Further, this study engaged and applied a formula for defining the number of health district, most of these HFs were primary health care facilities and a few secondary HFs (even though a 15% sample is determined) to be selected per health care facilities and from each of the selected health district. They are described below and bearing in mind that hundred percent (100%) of the counties (15) are automatically and purposively selected for the study.

Also to best ascertain a scientific method aside the simple random sample used, the formula of a minimum sample size of PHC facilities /over the total Number of PHCs facilities x Number of PHCs available for selection in the selected district health areas was engaged.

The number of PHCs facilities in various health districts areas of 15 counties Montserrado, River Gee, River Cess, Maryland, Nimba, Bomi, Sinoe, Grand Bassa, Grand Kru, Grand Gedeh, Lofa, Grand Cape Mount, Gbarpolu, Bong and Margibi. Liberia Malaria indicator survey (LMIS, 2022) was 923 out of the 93 health districts as below. Fifteen percent (15) gave a total of Fourteen (14) health districts and 138 health facilities as seen below.

Hence, the number of health facilities engaged in the selected health district areas are.

Health facilities = 138/923 x 856 = 127 health facilities

Making a total of one hundred and twenty-seven (127) health facilities (HFs) under the health districts to be used in the study. At health district level, a basic random sampling (SRS) method was employed. to select health facilities and the process continued with the list of HFs until the required number for each of these 127 was obtained. The health districts and health facilities are represented below

Stage 3 Health personnel selection for samples.

Step 1: Health personnel list or total staff presented by ministry of health in the 93 health districts was estimated at 850 at the health facilities who are either data officer, data clerks, monitoring and evaluation, medical personnel, etc., as stated below. However, various health personnel who were interviewed during the study for either key in-depth interview (KII), focused grouped discussions (FGD) are as follows; HMIS leads at the MOH (2), HMIS officers at ministry of health NMCP (4), Counties health officers (10), District health officers (7), PHCs leads (11), Medical officers of health (9), Facility nurses (15), Community health volunteers (15), Community Health Extension Workers (CHEWS) (10), Lab technicians and Phlebotomy (13) Monitoring and Evaluation/Data entry personnel (33) due to availability and being the data person in-charge at the facilities or data officers during the time of the study.

Exact figure of respondents' health staffs being selected for this study was aggregated according to characteristics for each category by taking samples from existing and available number of health worker provided by MOH, this is provided in the table below:

Table 4

Counties and Health Facilities Malaria Personnel

Counties	Number of health personnel at facility (malaria)
Montserrado	397
Bomi	56
Bong	58
Gbarpolu	52
Grand Bassa	35
Grand Cape Mount	35
Grand Gedeh	34
Grand Kru	30
Lofa	71
Margibi	68
Maryland	37
Nimba	87
River Cess	20
River Gee	41
Sinoe	37
Ministry of health	13

This table represents counties and health personnels. Curled from human resource department of MoH. MOH HR report was provided by human resource department of ministry of health (MOH-HR report, 2023).

Health worker respondents chosen from each group were considered using the estimated quantity of health workers provided; nevertheless, the study emphasis was on fifteen percent (15%).

Selected sample size / Total number of all district health workers in the county

x total number of each category health workers in each of the counties

Total selected sample size = 161

Total of number of health workers in counties (aside community health workers under MoH = 850) = 1072.

For Nursing Officers = 15/1072 x 850 = 11.8 = 12

Community Health Officers = 15/1072 x 850 = 11.8 = 12

Community Health Extension Workers = 10/1072 x 850 = 7.9 ≈ 8.

Pharmacy and Phlebotomy = 13/1072 x 850 = 10.3 ≈ 10.

Laboratory Technicians = 10/1072 x 850 = 7.9 ≈ 8.

Monitoring and Extension/ Medical Records Officers = 10/1072 x 850 = 7.9 ≈ 8.

Monitoring and Evaluation/Data entry personnel = 33/1072 x 850 = 26.1 ≈ 26.

Step 2: Determining number of total health workers (respondents) to be distributed to each of the health facilities at health districts for study proposes. The equation applied for this computation was:

Sample size of health staff in category / Total number of health workers in county represented by the health districts x Total number of health staff in each of various health districts at the county.

All of the existing health staffs who are one way or the other connected to management of data in different health facilities and government structures that includes the MOH was included in this sample, this is calculated below, and a simple random sample was used or drawn out to determine the number due to unforeseen circumstances that may occur.

Step 3: In each of the selected health district staffs considering each of the 15 counties, a straightforward random sampling (SRS) method was utilized to choose the necessary number of health workers involved. in this study as earlier described using total number of health facilities workforce available within selected study health districts.

Materials/Instrumentation of Research Tools

For this study, no existing validated tools were used for data collection. However, designed tools were submitted and approved by the school UREC that accommodates the key research goal, objectives and hypothesis through student permission that was approved.

To achieve the research objectives, key and suitable data collection tools and processes are adopted after the sampling techniques have been agreed upon to ascertain what facilities and staff will be engaged. Considering that qualitative and quantitative research approaches enhance findings' integrity as Bryman (2006) had argued, a mixed-method research approach is utilized here to gather and analyze quality data. Additionally, qualitative research seeks to investigate and depict the phenomenon, while quantitative research will engage in description and explanation (Al Zefeiti & Mohamad, 2015; Bryman, 2006).

Also, while the quantitative method in this research investigated the relationship between data capture, usage and decision-making, the qualitative approach examines issues associated with processes and work of health staff and systems involved in functional HMIS (Al Zefeiti & Mohamad, 2015; Bryman, 2006). Quantitative designs also addressed sample size, including data types collected, sampling engaged, data gathering techniques, data organization and examination strategies. While qualitative study data gathering utilizes interviews, focus groups, and discourse analysis for this study (Al Zefeiti & Mohamad, 2015; Bryman, 2006).

Also, many significant variables of interest in this research were not meant to be manipulated, mainly because data epistemology is of more importance to addressing global health planning (Johnson, 2001).

Therefore, this research engaged a mix of purposive, stratified, and random sampling methods for participants' selection at the health facilities to be interviewed and surveyed; the intended demographic for this research will be individuals engaged in or responsible for decision-making from the critical high-level ministries and counties, record, monitoring and evaluation staff of each health facility across selected facilities from the 15 counties in Liberia. Coughlan. et al. (2007).

Data collection method and tools

The methods for data collection involved a mixed-method strategy (qualitative and quantitative) using a designed or structured questionnaire template to collect critical quantitative data from vital health ministry and facilities staff. Key informants' interviews with participant observers that include FGDs were employed for the qualitative approach that will help produce key statistic elements for analysis in the research. Coughlan. et al. (2007). Face-to-face interviews, face-to-face questionnaires and phone interviews will be conducted.

While the qualitative data gathering process involved in-depth interviews and focus group discussions that encompassed case studies and ethnography for observations, Krauss. (2005). Quantitative data collection was conducted via a structured questionnaire to respond to research questions and comprehend processes in the health systems (such as "How has the health management information system developed and evolved over the past five years? "and "How reliable and appropriate the malaria HMIS data for malaria control decision-making has been?" "What determines the supporting factors to effective HMIS strengthening for malaria control in

the country?" and "How has the use of HMIS data supported planning in malaria prevention and control?"). The data collection process depended on historical data spanning four years or more as questions arose to help identify policy-relevant data such as the burden of malaria, diagnostic procedures, and treatment practices (Kunimitsu, 2009).

A case study design with a structured tool design using a mixed-method approach will engage the respondents. This will help the research triangulate information through influential data culture of best practice. Data was collected at health facilities, regional health facilities and the primary data collection levels at the Ministry of Health using document review, survey, in depth interviews of key informants, direct participation, and direct observation of practices. Qualitative data will be collected to answer research questions: "How has the health management information system developed and has evolved in the past five years? "and "How reliable and appropriate the malaria HMIS data for malaria control decision-making has been?" "What determines the supporting factors to effective HMIS strengthening for malaria control in the country?" and "How has the use of HMIS data supported planning in malaria prevention and control?" While both quantitative and qualitative data will be used to answer the research question, "How reliable and appropriate the HMIS data for malaria control decision-making has been?" The proposed study data process is divided into two components. This will help attain a generalization of the outcome. In the initial component, the caliber of data produced by the essential sentinel health facilities will be examined, and high-quality policy-relevant data will be continuously recognized. In the subsequent component, this data will be presented to decision-makers and used to explore how evidence is perceived and used to (a) further strengthen the health information system and (b) inform decisions about malaria control in an ongoing manner over three years.

Data was collected at health facilities, regional and central levels across all the 15 counties in the country using techniques and tools that capture in-depth data as mentioned above, including interviews, Focused Group Discussions, questionnaires, Observations and Documentation to gather real-time information. In this research, the data collection process included both the researcher's presence and research assistants because of the nature of the country's data storage on the HMIS that must be extracted. The qualitative approach was engaged in the Liberia health information system research investigations because of its ability to achieve a natural and valuable understanding of the research phenomenon needed for first-hand information, as demonstrated by (Hussey and Hussey, 1997; Alexander, 2002).

That is an intelligent design and approach that will achieve a genuine and valuable understanding and context characteristics through observing from an objective point of reality in the study (Hussey and Hussey, 1997; Alexander, 2002).

Because of restricted funding, the research employed probability and non-probability (purposive) sampling techniques to choose sample sizes from the respondents and facilities included involved in the Liberia health system (it did not commit to the whole health facilities).

The developed study tools were pre-tested (administered at a Primary HF in the capital city) with key M&E and facility staff to ascertain in language and clarity of the data collection process before being rolled out to other facilities in the country as displayed below.

Instruments choices for HMIS evaluation regarding operational capacity at the district levels.

All the one hundred and thirty-eight (138) Health Care facilities (that includes primary, secondary and tertiary) selected earlier from the country’s 923 health facilities were

employed for facility operational capacity assessment that includes primary, secondary and tertiary health centres that implement HMIS processes. This also includes MoH facilities and community health facility workers and also excludes private owned health facilities.

Study health facilities selection to assess data quality and information flow

Some health facilities were selected to further understand some data quality issues that affects data flow and causes some key decision-making gaps as described by the data Liberia (DQIP, 2022 - 2027). Data quality evaluation was conducted during the essential in-depth interviews (KIIs) and the Focused Group Discussions (FGDs) involving medical and data personnel, the data quality assessment interview was carried out at the selected 138 facilities including the ministry of health MoH 5 selected health facilities during this process. From the one hundred and thirty-eight (138) selected Primary Health Care facilities, the study randomly at least one each from each of the selected health district areas for the data quality interviews. This method is founded on the Revised World Health Organization's criteria for On-Site Data Verification (OSDV) and Rapid Services Quality Assessment (RSQA) (Esene, 2015; (WHO, 2014). This processed was agreed and carried out in two consecutive months through the engaged field officers prior to this study (dating between December 2022 through to August 2023). These engaged health facilities for the research were randomly selected using simple random method to further strengthen the logic of sampling, in giving equal opportunities to all objects in a survey (Macfarlane, 1991; Esene 2015).

Selection of senior staff participants for Key Informant Interviews (KII)

This was a purposive selection due to the fact that the directors are already known for this key informant interview and the senior staff selected by the malaria program, ministry of health or the district heads will be the ones to be interviewed. In the selection for interview, we were assisted by the ministry leads who appointed the staffs to be interviewed. In all, Assistant director of HMIS unit was engaged, a senior MOH employee and a community health worker, a district health physician who manages HFs, a planning staff member, research and statistics department, 2 MOH pharmacies and 2 senior staffs from malaria program were all purposively chosen for the KII process. A few of the interviews were done on telephone due to the non availability of the senior staff as at the time of this interview, communication cost was provided for the research assistants and a few of the staff.

Selection of senior staff participants for in-depth interview (IDI)

A purposive sampling method was also utilized to choose participants (coordinators) for the In-depth Interview conducted at the district and facility levels, however simple random sampling as indicated earlier was used in selection of HFs but with known participants. The coordinators of the PHC and the officers responsible for the chosen health districts and health facilities were either nurses or medical officers in these identified health districts, as previously noted they were intentionally selected for the comprehensive interviews.

Selection of study participants for Focus Group Discussion (FGD)

For the focused group discussions, the facilities were randomly selected but in the far-off facilities there were some purposive selections because of logistics reasons and transportation cost. One FGD session was done for each of the combined 3 to 4 health facilities

with 10 to 12 participants for a group. For each FGD group interview session, 10 to 12 health workers were selected, and this group comprises of HF staff's representative from districts and counties, also different level of staffs handling data and good data experience. However, for the senior staff at the district level, 5 to 10 medical staff made a group.

Operational Definition of Variables Study

The dependent variable in this research is malaria data as the quantitative variable being measured in this study; this is mainly measured using hypothesis 3 (third hypothesis).

This study focuses on quantitative malaria data on the District Health Information System (DHIS2) of the Liberia ministry of health as the only dependent variable collected and inputted or entered from patient files.

The study sampling also used a probability (simple random sampling) and nonprobability (purposive) sampling method.

Since some portions of the dissertation research population is already known such as key informant Interview KII and In-depth Interview IDI including Focused Group Discussions FGD, the other portion will be the health facility staff (such as the participants from the malaria department of the ministry of health and the HF data entry staff or HMIS personnels) will be selected through a simple random sampling. The health facilities including health districts were also randomly sampled but a non-probability purposive sample was used to select the model. Then, a probability sample (simple random sample) was employed to select HFs and partakers for the study.

Since the research drew on a mixed research design, a probability and non-probability sampling technique allowed this study to make statistical inferences (i.e., generalizations) from our sample of HFs information and DHIS2 data.

The sampling strategy is chosen probability and non-probability sampling

The specific sampling technique used: purposive sampling

The research questions and Hypothesis followed the trend below

Q1. How has the health management information system developed and has evolved in the past five years?

Q2. How appropriate is the malaria HMIS data for malaria control decision-making?

Q3. How has the use of HMIS data supported planning in malaria prevention and control?

Q4. What are the expected determinants to effective HMIS strengthening for malaria control in the country?

Hypothesis1

H1o: The HMIS is not appropriate for malaria control decision making

H1a: The HMIS is reliable and appropriate for malaria control decision-making.

Hypothesis 2

H1o: The HMIS has not been pictured and used correctly.

H1a: The HMIS has been pictured and used correctly.

Hypothesis 3

H1o: Decisions on Malaria prevention and control have not been made using valid HMIS data

H1a: Decisions on Malaria prevention and control have been made using valid HMIS data.

The research hypothesis (3) and analysis are carried out by engaging quantitative data measuring the disease burden trend; SPSS analyzed the malaria testing and treatment burden/volume data; questionnaires were coded and categorized for entry into the SPSS for data analysis and to produce real-time information for this research, data editing was conducted to be sure questionnaires are correctly filled and ensure data quality. Anthony. (1984). So, quantitative data was engaged with SPSS to produce a real-time result trend for this research using Pearson correlation to test between the number of malaria patients tested vs malaria patients treated and year by year trend across five years. Further, SPSS was engaged because of its ability to handle extensive data and perform rigorous analysis.

Key to the quantitative research method is that statistics is turned into a reliable resource of information for a reliable decision-making process; this research draws its validity from the strength of Hussey and Hussey's view on real data perceptions for crucial decision-making.

Quantitative research primarily focuses on the positivistic researchers' conviction that the social realm comprises tangible and unalterable reality that is measured objectively (Hussey and Hussey, 1997).

Then, the quantitative that in the interpretive researchers' view, opposes the belief of reality. It argues that humans socially construct validity. And they can understand their perceptions of their activities, which can be understood subjectively (Hussey and Hussey, 1997).

Study Procedures and Ethical Assurances

This study underwent a rigorous review and received approval from UREC and the Liberia ethics committee (ACRE IRB) before data collection; the ethical assurance was carefully reviewed and guided to avoid confidentiality challenges or misinformation.

Processes followed

Consent will be obtained from the Ministry of Health and the National malaria control programme (NMCP) through the gatekeepers to seek approval before the study data will be collected, the study will also involve key national malaria control programme (NMCP) staff for further guidance. Additionally, a developed gatekeeper tool was approved and distributed.

The health facility malaria data from the system/database (DHIS2) will be coded and does not carry patient details, so no patient's name will be mentioned for the quantitative data; the involvement in HF and respondents' selection by the ministry and national malaria program will minimize any ethical issues. Also, consent forms will be distributed to all participants of the Focused Group Discussions (FGD), Key In-depth Interviews and observations before participants are engaged in the study with the right to voluntarily opt out if not satisfied. The Observations will be carried out at a few facilities to understand how data is entered into the HMIS tools and what next steps it follows with interfering with staff activities or interacting with any patient at the HFs. Further, before the report is published, consent will be obtained from the federal malaria program and ministry.

In addition, any data entry staff or health staff or participant whose emotions do not accept such study or is not mentally stable during this process will not be engaged in other not to tamper with any emotions.

Ethical Assurances

Importance or relevance of ethics in research

Before their articles may be published, international and local social science journals, as well as scholars, researchers, and authors, must insist that authors provide proof of ethics approval (Mamotte and Wassenaar, 2009). However, in social research studies like "health diseases" that address very delicate topics and use individual and group data as the focus of their inquiry, ethical considerations for protecting participants take precedence (Benatar, 2002; Benatar & Singer, 2000). In sensitive studies of this natural health and data research, data collection was and must be handled delicately, and all ethical standards during this study were upheld because the findings might be generalized to a particular environment or community.

Informed consent

As Benatar expressed in a 2002 article that ethical merit involves honoring the dignity of research subjects (their integrity, privacy, safety, and human rights thereby the necessity for informed consent), the obligation to reduce risk, to weigh risks against benefits, to offer suitable compensation for time, to ensure compensation for any harm that may arise during the research, to safeguard confidentiality (Benatar, 2002).

From an understanding of (Benatar, 2002), informed consent is critical in social research because it ensures that individuals and groups voluntarily participate in the study with full knowledge of relevant risks and benefits to both the researchers and the participants. This shows that participants understand what they are partaking in and what the research requires, such as the malaria program and the Ministry of Health (Benatar, 2002).

Informed consent gives researchers the privilege to dialogue with the participants on the methods of storing data, using their information, and having access to the research material

(Surmiak, 2018). This is why it is critically considered for the sensitive study of this research, focusing on patients' data.

Confidentiality

The protection of information in any research field is expected to be the highest priority in research; researchers are expected to safeguard the identities of their research participants against any risk that could cause harm (Haggerty, 2004). The rights of benefactors or participants still raise their head in the issue of confidentiality and anonymity, the respect for the dignity of participants as described by (Fouka. & Mantzorou, 2012), "be of benefit" and "no harm" remains massive issue of ethical principles in which protecting or benefitting the individual or community is of the essence.

Therefore, this is why the anonymity and confidentiality of this research respondent are mainly kept, and information protection is about the researcher not disclosing information unless the study participants consent is the sort to its disclosure and even then, only in ways to which they agreed.

Respect for privacy/Persons

In this research study, every participant has a right and must know that they can withdraw at any time and have any of their data already recorded removed from the analysis in case of harm where this is possible.

It becomes a principle against ethical research regulations as agreed upon and approved by the UREC for a researcher to decide on behalf of participants on delicate issues. This action does not promote fairness and respect or violate their right to dignity (Fouka. & Mantzorou, 2012). As again expressed by Benatar & Singer, there is an importance in understanding that not everyone, particularly those who are marginalized or who have faced exploitation, will view the world with

the same perspectives and therefore sensitivity to these facts is very important in studies (Benatar & Singer, 2000).

Data Collection and Analysis

Samples and samplings (Mixed method)

Since qualitative and quantitative research approaches enhance the findings' integrity, a mixed method is employed here to collect and analyze quality data in this research study. Palinkas et al. (2015). Further, qualitative research seeks to investigate and depict the phenomenon during data gathering. and use, while quantitative analysis will describe and explain the malaria trend (Al Zefeiti & Mohamad, 2015; Bryman, 2006).

Data collection method and tools

The data collection methods will be a mixed-method approach (qualitative and quantitative) using a designed or structured questionnaire template to collect critical quantitative data from vital health ministry and facilities staff. Key informants' interview with participant observers that include FGDs will be employed for the qualitative approach that will help produce key statistic elements for analysis in the research (Coughlan. et al, 2007).

While the qualitative data collection process engaged in comprehensive interviews and focus group discussions that featured case studies and ethnographic observations (Krauss, 2005), the quantitative data gathering was performed using a structured questionnaire to address research questions and comprehend processes in the health systems (Krauss, 2005). The data collection process depended on historical data spanning four years or more as questions arose to help identify policy-relevant data such as the burden of malaria, diagnostic procedures, and treatment practices (Kunimitsu, 2009).

Data was collected at health facilities, regional and central levels across all the 15 counties in the country using techniques and tools that capture in-depth data as mentioned above, including interviews, Focused Group Discussions, questionnaires, Observations and Documentation to gather real-time information. that will entail 6-10 and 10 to 12 as the situation warrants per group of participants selected from close facilities around the districts, questionnaires, Observations and Documentation to gather real-time information. It is expected that during the study process, the estimated number of Focused Groug Discussion (FGD) participants will be provided with transport fares if taken to HFs that are far from theirs. Also, for Key Informant Interview (KII) that is conducted on phone, the researchers will have communication cost to carry out these interviews. In this research, the data collection process included both the researcher's presence and research assistants because of the nature of the country's data storage on the District Health Information System (DHIS2) through the Health Information Management System that must be extracted. The qualitative approach was engaged in the Liberia health information system research investigations because of its ability to achieve a natural and valuable understanding of the research phenomenon needed for first-hand information, as demonstrated by (Hussey and Hussey, 1997; Alexander, 2002).

That is an intelligent design and approach that will achieve a genuine and valuable understanding and context characteristics through observing from an objective point of reality in the study (Hussey and Hussey, 1997; Alexander, 2002).

Owing to restricted financial resources, the research utilized both probability and non-probability (purposive) sampling techniques to determine sample sizes from participants. and facilities involved in the Liberia health system (did not engage the whole health facilities). The

sample variables include the DHIS2 malaria data sets (independent) and the ministry of health staff (dependent).

Summary

Data analysis

The study employed an inductive method in its examination, acknowledging that qualitative research is an important framework of inquiry in the investigation; furthermore, to attain a deeper analysis, a thematic analysis is utilized for recognizing, examining, and documenting patterns (themes) in the data. UNICAF lecturer's (note, 2022).

This study engaged the NVIVO qualitative analysis software to analyze extensive data, including unstructured text, audio, images, and video data from interviews, FGD, etc. However, manual coding was used for a small amount of data gathered that should not be ruled out at some levels. Since this study relied on a large amount of information and was time-consuming in its data collection process, it utilized NVIVO, which accommodates and analyses extensive data. Further, NVIVO has the strength of analyzing précised words from individuals and groups of the same roots, such as primary facilities, districts, counties and country levels in deriving meanings to the study (Lofgren, 2013). It was also engaged in analyzing other forms of qualitative data collection such as observation scripts and FGDs audio tapes that will be fully transcribed as much as possible to make extracts for analysis, transcriptions and theme usage was engaged with respondents' information using manual coding because of the small amount of data in a storytelling manner to obtain a clear comprehension of the nations' HMIS frameworks (Ho, 2006).

However, in the latter part of the study that engaged quantitative data measuring the disease burden trend, SPSS analyzed the malaria testing and treatment burden/volume data; questionnaires

were coded and categorized for entry into the SPSS for data analysis and to produce real-time information for this research, data editing was conducted to be sure questionnaires are correctly filled and ensure data quality (Anthony, 1984).

So, Quantitative data was engaged with SPSS to produce a real-time result trend for this research using Pearson correlation to test between the number of malaria patients tested vs treated and the year-by-year direction across five years. Further, SPSS was engaged because of its ability to handle extensive data and perform rigorous analysis. At the same time, qualitative data did not only engage NVIVO but was also transcribed and coded. The structuration theory will be engaged by applying social theory to enrich the qualitative result (Anthony, 1984). These data analyses will be descriptive and inferential statistics approaches; this will help the research study find a steady pattern.

Many scholars, including (Azubuike & Ehiri, 1999), globally agree that the Health Information system can provide many benefits because accurate and timely health intervention coverage has been a significant fulcrum of public health practice. If properly addressed, it will lead to increased health accountability and enable bodies to enhance the capability to track advancement towards international, national, and sub-national aims and targets (Dehnavieh. et al, 2018).

This research design used a simple random and purposive sampling scheme to select a representative sample for this study. The intended group consisted of malaria personnel from the ministry of health and data entry clerks/officers from health facilities in all 15 counties in Liberia. Also, all data staff of these facilities can be selected and use the designed structured face-to-face and hand-administered questionnaire for responses. This tends to comprehend the development and operation of health information, HMIS and its importance in making relevant decisions related

to malaria prevention as described by the Liberia malaria indicator survey (LMIS, 2022). The unit to be measured is the malaria data collected and entered the DHIS2 database for the country.

The HMIS data on DHIS2 is a countrywide database for malaria so that the quantitative analysis will depend on the national data from 2015 to 2020 on the DHIS2 platform. This is a purposive sample population to be used in this research.

As discussed earlier, the qualitative data drew a sample from the population of 923 health facilities (HFs) from 93 districts health areas in 15 counties of the country, with approximately 850 HIS officer/M&E/data entry staff (this study regards data entry staff to be the officer in-charge of data regardless of the nomenclature, any staff why enters data will be interviewed) at health facilities (including Tertiary, secondary and primary). A random sample of 15% is drawn for the health facilities to have 138 HFs and estimated 128 data staff recruited for the study responses.

Liberia has Fifteen Counties and 93 Health Districts. In the country as mentioned earlier, there are eight hundred and fifty-six (856) as outlined by the DQIP as functional health facilities out of 923 (HMIS facility data) on the DHIS2 platform. submitting services delivery report through the DHIS2 and Nine Hundred & Sixty-Four (964) on the Master Facility Listing. Liberia (DQIP, 2022 – 2027).

The data collection methods will be a mixed-method approach (qualitative and quantitative) using a designed or structured questionnaire template to collect critical quantitative data from vital health ministry and facilities staff. Key informants' interviews with participant observers that include FGDs were employed for the qualitative approach that will help produce key statistic elements for analysis in the research (Coughlan. et al, 2007).

All the one hundred and thirty-eight (138) Health Care facilities (that includes primary, secondary and tertiary) selected earlier from the country’s 923 health facilities were

employed for facility operational capacity assessment that includes primary, secondary and tertiary health centres that implement HMIS processes. This also includes MoH facilities and community health facility workers and also excludes private owned health facilities.

Some health facilities were selected to further understand some data quality issues that affects data flow and causes some key decision-making gaps as described by the data Liberia (DQIP, 2022 - 2027). Data quality evaluation was conducted during the essential in-depth interviews (KIIs) and the Focused Group Discussions (FGDs) involving medical and data personnel, the data quality assessment interview was carried out at the selected 138 facilities including the ministry of health MoH 5 selected health facilities during this process. From the one hundred and thirty-eight (138) selected Primary Health Care facilities, the study randomly at least one each from each of the selected health district areas for the data quality interviews. This method is founded on the Revised World Health Organization's criteria for On-Site Data Verification (OSDV) and Rapid Services Quality Assessment (RSQA) (Esene, 2015; (WHO, 2014). This processed was agreed and carried out in two consecutive months through the engaged field officers prior to this study (dating between December 2022 through to August 2023). These engaged health facilities for the research were randomly selected using simple random method to further strengthen the logic of sampling, in giving equal opportunities to all objects in a survey (Macfarlane, 1991; Esene 2015).

This was a purposive selection due to the fact that the directors are already known for this key informant interview and the senior staff selected by the malaria program, ministry of health or the district heads will be the ones to be interviewed. In the selection for interview, we were assisted by the ministry leads who appointed the staffs to be interviewed.

In all, Assistant director of HMIS unit was engaged, a senior MOH employee and a community health worker, a district health physician who manages HFs, a planning staff member, research and statistics department, 2 MOH pharmacies and 2 senior staffs from malaria program were all purposively chosen for the KII process. A few of the interviews were done on telephone due to the non availability of the senior staff as at the time of this interview, communication cost was provided for the research assistants and a few of the staff.

A purposive sampling method was also utilized to choose participants (coordinators) for the In-depth Interview conducted at the district and facility levels, however simple random sampling as indicated earlier was used in selection of HFs but with known participants. The coordinators of the PHC and the officers responsible for the chosen health districts and health facilities were either nurses or medical officers in these identified health districts, as previously noted they were intentionally selected for the comprehensive interviews.

For the focused group discussions, the facilities were randomly selected but in the far-off facilities there were some purposive selections because of logistics reasons and transportation cost. One FGD session was done for each of the combined 3 to 4 health facilities with 10 to 12 participants for a group. For each FGD group interview session, 10 to 12 health workers were selected, and this group comprises of HF staff's representative from districts and counties, also different level of staffs handling data and good data experience. However, for the senior staff at the district level, 5 to 10 medical staff made a group.

The research used an inductive approach in its analysis, considering that qualitative research is a significant design of enquiry in the study; also, to achieve a more profound analysis,

a statistical analysis is utilized for recognizing, examining, and documenting patterns (themes) in data. UNICAF (lecturer's note, 2022).

This study employed the NVIVO qualitative analysis software to analyze extensive data, including unstructured text, audio, images, and video data from interviews, FGD, etc. However, manual coding was used for a small amount of data gathered that should not be ruled out at some levels. Quantitative data was analyzed with SPSS to produce a real-time result trend for this research using Pearson correlation to test the relationship between the number of malaria patients treated and the year-by-year direction across five years.

To assure ethical issues, the health facility malaria data from the system/database (DHIS2) will be coded and not carry patients' details, so no patient's name will be mentioned; the involvement in HF and respondents' selection by the ministry and national malaria program will minimize any ethical issues. Further, before the report is published, consent will be obtained from the federal malaria program and ministry.

CHAPTER 4: FINDINGS

Gaps in Health Information System structure around Africa

The aspiration to achieve superior data that tackles health issues in nations has posed a significant challenge for the health sector in Africa; developing and strengthening health information systems (HMIS) at the country level becomes paramount (WHO, 2018).

With the focus on Liberia's health systems and a specific focus on malaria information, where the entire population is approximately 5.057 million, the United Nations Population Division (UNDP, 2019) revision claims this number of individuals may face potential risk (UNPD, 2019). Malaria has emerged as a major health issue in Liberia, as stated in the Liberia Demographic Health Survey and the Liberia Malaria Indicator Survey which stated that children under five and pregnant women are the most impacted groups, constituting the highest percentages of risk in malaria (LMIS, 2022; UNPD, 2019; LDHS, 2019). This malaria situation in sub–Saharan Affrica was also emphasized by the world health organization. (WHO Health Facility Survey [HFS] report, (2018). The WHO health facility report indicated that Malaria continues to be the primary reason for illness and death, representing 34% of all outpatient visits and 48% of all inpatient cases in Liberia (LDHS, 2019; HFS, 2018).

One of the findings from the desk review using the Liberia Data Quality Improvement Plan – (DQIP) which was a plan that had some constituted members to assess the current and current strengths and flaws of the data system for additional systems enhancement in the upcoming five (5) years, this report showed some of the weaknesses and strength, these strengths and weaknesses is said to be identified in other to further strengthen

the data systems of the country but especially that it should be emanating from the HIS unit of the MOH data base for routine data.

Data quality improvement plan in Liberia

This study in its findings also reviewed the historical and logical trend of data quality assurance and improvement in Liberia, the study background had indicated the effect of quality data on analysis and decision making for planning in its literature review. Hence, the study found out that Data management at present in Liberia has encountered several significant challenges, which include incomplete, inconsistent, and delayed reporting noted from the primary health facilities of communities, other health facilities at the district's levels, Counties and the central National level as indicated by the Data Quality Improvement Plan (DQIP, 2022 – 2027).

The Liberia DQIP planning, and development engaged and carried out these processes as described below to come up with the DQIP document: The initial proposed framework for the document contained five (5) phases: It begins with a team assessment of the design and structure of the information system (phase one), and an evaluation of the data collection processes (phase two) (DQIP, 2022 – 2027). Both of these tasks have contributed to enabling document reviewers to fully understand the country's data perspective and models, and to further build a data quality plan through a five-phase framework for a data quality review (DQIP, 2022 – 2027). These phases included:

Table 5

Five Phase Framework

Systems Assessment	Data Desk Review	Field Review	Improvement Planning	Output
-People -Tools -Processes -Governance. Liberia DQIP. (2022 – 2027).	-Timeliness and completeness -Internal consistency -Trend analysis Triangulation. Liberia DQIP. (2022 – 2027).	-Qualitative assessment -Data verification. Liberia DQIP. (2022 – 2027).	-Root cause analysis Prioritization -Action plan Implementation and Monitoring -Activity Implementation -Regular review against action plan -M&E of intervention. Liberia DQIP. (2022 – 2027).	-SWOT analysis, data flow scheme - Output: analysis, visualizations - Output: presentation of findings -Output: recommendations, improvement plan - Output: Robust M&E Implementation, against plan. Liberia DQIP. (2022 – 2027).

The table above shows the five-phase Framework in Liberia (DQIP, 2022 – 2027).

This Liberia (DQIP, 2022 – 2027) report provided a concise overview of the health information system deficiencies and obstacles that impact data quality for reporting, intervention planning, and crucial recommendations; the report also highlighted the components of the health information system that appear to be robust and praiseworthy throughout the country, which includes one of the primary focuses of the research centering on the availability of the health information system framework to facilitate decision making, policy development, guidelines, and strategic plans (DQIP, 2022 – 2027). Furthermore, the report noted additional significant areas of success and strengths that encompass the presence

of an integrated data platform that collects information from all disease prevention and control programs, along with a set of essential indicators to monitor data flow and committed personnel at the central level MoH for data analysis/processing for enhanced decision making and policy development (DQIP, 2022 – 2027).

However, a significant advantage for the health information system and its structure is the HIS unit acting as the national repository for all health data. This Health Information System unit of the ministry of health, as part of its responsibilities, also offers leadership and guidance on the development and upkeep of all health information sub-systems, spearheads the creation of standardized data collection and reporting tools, manages the national diseases data flow, directs routine data collection processes, and coordinates or implements strategies to enhance health data quality, which includes archiving all health data (DQIP, 2022 – 2027). This important and very significant data coordination role of the unit at the MOH will further enable one data system, one reporting system and improve decision making that improves health planning for the country health intervention and disease control.

Health Management Information System HMIS structure performance and use

A 2022 comparison from the "A *performance of Routine Health Information System Management in Liberia PRISM Assessment*" (Measure, 2014).

Table 6
Health Management Information System Performance Comparison

HMIS performance indicator. Measure (2014)	Facilities		Districts		Facility	District
	2012	2014	2012	2014	2022	2022
PERFORMANCE OF RHIS. Measure (2014)						
Quality of data (Measure, 2014).						
Overall accuracy	54%	84%	78%	88%	92%	94%

Data completeness in facility monthly reports	52%	79%				
Completeness of monthly reports at county level			91%	98%	56%	98%
Timeliness of reports of health facilities at county level			74%	88%	63%	95%
Use of information	38%	58%		75%	50%	75%
PROCESS (Measure, 2014).						
HMIS procedure manual		62%			70%	
Verification of Data quality	63%	79%			80%	
Filling out of reports in full	72%	81%			85%	
Sending of reports before the deadline	85%	87%			88%	
Feedback to health facilities	20%	49%		50%	20%	55%
Data analysis (Measure, 2014).						
Presence of performance targets	33%	35%				
Presence of performance monitoring plan	15%	33%		100%	30%	100%
Performing at least two types of data analysis	15%	39%		100%	40%	100%
Display of data	45%	68%		54%	75%	60%
Supervision (Measure, 2014).						
Effective supervision	45%	73%			45%	20%
Data quality control	82%	97%				
Feedback after supervision	22%	89%				
DETERMINANTS OF HMIS PERFORMANCE. Measure (2014)						
Technical factors						
Simplicity of the reporting forms		58%		80%	80%	85%
Simplicity of the software package				100%	45%	95%
Organizational factors (Measure, 2014).						
Governance Documentation			75%	80%		80%
Planning documentation			44%	69%		
Financial documentation on the RHIS			33%	50%		
Training Schedule			0%	75%		85%
Supervision schedule			80%	100%		100%
Promotion of information culture			48%	58%		
Trained personnel in charge of the HMIS						50%
Behavioural factors (Measure, 2014).						
Awareness of the rational for HMIS	28%	43%	54%	59%	50%	60%
Knowledge of data quality checking methods	10%	33%	29%	59%	30%	60%
Problem solving skills	8%	24%	27%	61%		
Skills observed in performing HMIS task	9%	22%	45%	49%	25%	49%
Self confidence declared in performing HMIS task	51%	68%	71%	80%		
Motivations for carrying out HMIS tasks	62%	66%	60%	65%	40%	55%

Measure Evaluation report. (2014).

Curled from Health management Information System performance comparison. Measure. (2014).

The table above shows the Health Management Information System structure and data use performance between 2014 and 2022 of implementation; this performance is recorded in 2022 after eight (8) of the Liberia data systems (Measure, 2014).The Measure 2014 assessment reported that in April 2012 a baseline assessment was carried out to ensure a basis for comparison which is why this report also depended on the 2014 reports for further performance assessment, this performance baseline assessment of the HMIS becomes paramount for key health information systems improvement measures, the PRISM frameworks and tools were not used to carried out the 2022 performance improvement but the Liberia Ministry of Health HMIS data and health facility information was utilized for additional performance comparison (Measure, 2014).

This study has used implementation data and key interviews to further support its findings. Furthermore, going by the study evaluation of quality of data and usage as assessed at the facility and health district level, the results are displayed in the table above. Some determinants of the HMIS performance as shown on the table were just above average level after these eight years and employment of data for key decision made during this phase and timeframe was likewise assessed to be at a heightened rate of seventy five percent (75%). Thus, the suggestion from the previous evaluation (Measure, 2014) that guided the creation of initiatives for enhancing the HMIS in Liberia remains valid and should be further developed (Measure, 2014).

The assessment could not find some reports at the facilities and national level for complete assessment of performance during the study; however, some key significant data

and information were not absent as presented in the table above. However, the table further shows an improvement in data quality averaging 95%. Liberia PRISM Assessment. 2014.

Further, the correct and effective health management information systems are essential for reinforcing the health system. in developing countries, this research study as earlier specified focuses on bridging the gap by examining the challenges, completeness, use, and quality of HMIS in Liberia's health system. This study will assess the Health Information Systems (HIS), focusing on malaria in the Liberia health system as a case study.

The research will seek to enhance the nation's health management information system to foster an understanding of the development and operations of the health information system and its significance in decision-making pertaining to health planning, particularly regarding malaria prevention and control strategies in Liberia.

For these purposes to be attained, the key research questions are itemized as stated below.

Research questions.

Q1. How has the health management information system developed and has evolved in the past five years?

Q2. How appropriate is the malaria HMIS data for malaria control decision-making?

Q3. How has the use of HMIS data supported planning in malaria prevention and control?

Q4. What are the expected determinants to effective HMIS strengthening for malaria control in the country?

This research evaluates and studies the developing corridor of understanding between the product and functionality of the health management information system and its role in making profound decision through data on Liberia's malaria programme and control. I am continuing to investigate the elements influencing the capability of the health management information system to produce high-quality malaria-related data and to close the gap(s) in decision-making regarding malaria prevention and control.

Hence, critical decisions that are very significant and different from the existing challenging approach would be required and must be informed by high-quality data (LDHS, 2013).

It is thus essential that enhancing health information systems is vital for creating a more robust and sustainable health system. The research outlined key hypotheses to guide decisions and results that will further strengthen the health systems. Hence, the Liberia health information system study result will tend to promptly provide critical outcomes on the quality of data and how necessary it is for nations to react to requirements swiftly. Particularly during public health emergencies, a case in point is the Ebola epidemic in Liberia.

This chapter outlines the degree of confidence in the data and interpretation as regards the trustworthiness of the data engaged. This cuts across the data credibility, transferability, dependability and conformability and includes the study design (data gathering systems) that brings about the data generation and interpretation approach for significant decisions to be made.

The findings of the data analysis are also displayed in this chapter, and the techniques for data collection and analysis employed are likewise detailed in this chapter. The research utilized quantitative and qualitative data through the SPSS analysis package and NIVO.

Quantitative data. The primary data is derived from the national HMIS database for malaria and analyzed with the SPSS package. And the qualitative data, the primary data, is derived through Key Informant Interviews (KII), in-depth interviews (IDI), observations, and discussions in focus groups.

The findings are distinctly detailed under the research questions and hypotheses. They are organized in sections mainly corresponding to particular objectives and inquiries, including the socio-demographic attributes of participants, how the health management information system has progressed and advanced over the last five years, how reliable and appropriate the HMIS data for malaria control decision-making has been, how using HMIS data has supported malaria prevention and control planning and finally what determines the supporting factors for effective HMIS strengthening for malaria control in the country. Further, results were outlined using HMIS efficiency, effectiveness, and sustainability variables.

Trustworthiness of Data

Research results and generalizations, particularly in qualitative studies, will significantly rely on the credibility of the research and the level of confidence in the data and its interpretation, as posited by (Pilot and Beck, 2014). Pilot and Beck further utilize Guba's construct to associate the trustworthiness of a study with the level of confidence in the data, interpretation, and the methods employed to guarantee the quality of the research, according to (Pilot and Beck, 2014).

Although the reliability method is applied for the quantitative aspect of this study to establish the trustworthiness of data. This study on "*Understanding Health Information Systems and Decision-Making for Health in Liberia"* has used reliability by examining the consistency of the group responses and the measuring instruments (interview tools) responses used in the study (also known as internal consistency) (Shenton, 2004). This study also engaged the test-retest method (also known as stability) to prove reliability by administering a measure to the health facility data experts in 3 facilities in a county, waiting for a week and then re-administer the same instrument to the same data experts of the three health facilities to further ascertain the reliability of the responses.

The qualitative component followed the Guba construct rigorously, which was an essential criterion considered by positivist researchers in relation to internal validity, where researchers aim to guarantee that studies measure or assess what they are meant to and ensure credibility, a vital element in establishing trustworthiness (Shenton, 2004).

The trustworthiness of the data used for the study is outlined below.

Credibility

The adoption of research methods well established: This study found some key operational measures for the concepts being studied on health information systems and data flow, some specific procedures in line of questions intended or pursued in the data gathering sessions, and the techniques of data analysis were all obtained and in contrast, with some desk review from HMIS studies that used same information seeking procedures (Hussey and

Hussey,1997; Andrew, 2004). Referring to the article ‘‘The development of early familiarity with the culture of participating health workers” by (Shenton, 2004). It is essential that prior to the initial data collection discussions and pre-test occurring, there were consultations and reviews of relevant documents and preliminary visits to the personnel at the ministries and a health facility (Shenton, 2004). This facilitated a type of engagement between the researchers of this study and the intended participants for both groups to grasp the process and to build a relationship of trust between the parties (Shenton, 2004).

A random sample of information. A random selection of individuals to act as informants was first carried out from a set of participants; this marked the second phase, as the population had already been established for this research in the Liberia health system. While this research employed a purposive sampling method to choose the ministry and top hierarchy to be interviewed, a haphazard approach was used to determine the health facilities and their staff. The random sampling technique has assisted in guaranteeing that any unidentified influences are recognized, comprehended, and evenly allocated within the sample (for instance, various perspectives demonstrating traits of similarity, dissimilarity, redundancy, and diversity are pursued to obtain greater insight) (Shenton, 2004).

Triangulation. According to Shenton, this study has used a mixed method for data gathering and triangulated information, such as observation, focus groups and individual interviews, which constitute the primary data collection strategies of this research (Shenton, 2004). (Shenton, 2004), employing various research methods offsets their drawbacks and takes advantage of their individual strengths. Additionally, throughout this study, documents mentioned by participants during the data collection process (interviews or focus groups)

were also examined as these shed more light on the behavior of the data and malaria diseases (Shenton, 2004).

Frequent debriefing sessions: The researchers had frequent debriefs within the research team and the government personnel involved in the exercise; this helped to keep the study informed with current data and findings in the case of any misinterpretation.

Member checks, (Shenton, 2004) considered member checks as the most critical delivery that can be established to enhance a study's reliability further (Shenton, 2004). Data verifications concerning the precision of the data during the data gathering process were engaged (that is, on the spot, during the training, and at the end) (Shenton, 2004). The primary reason for member checks during the data collection was to emphasize whether the respondents considered that their words matched what they intended or what we had transcribed and accurately captured.

This also encompassed the validation of the researchers' developing theories and conclusions, as these were developed during the data gathering procedures and conversations with the teams. When suitable, participants were questioned to know if they could provide explanations for trends identified by the research, and all of these were elucidated (Shenton, 2004).

Thick description of the phenomenon under examination: an in-depth description in this domain can be crucial for enhancing credibility as it helps illustrate the real circumstances that have been explored and, to some degree, the related contexts Shenton, 2004). In the absence of this perspective, it is challenging for the audience of the final report to gauge the extent to which the results "ring true. " (Shenton, 2004). Additionally, if the investigator utilizes a reporting system where they delineate a set of categories within a

typology and demonstrates these categories using genuine qualitative instances, this research engaged rigorous and comprehensive documentation and interpretation of findings from this inquiry that extends beyond simply creating a superficial narrative of what participants have expressed based on observing or listening to them (Shenton, 2004). The research aims to comprehend participants' backgrounds in relation to their work, orientation, social and cultural context, values, objectives, and emotions (Shenton, 2004).

These inclusions of the objective qualitative evidence will allow the reader to evaluate how well the specified types of findings genuinely reflect the real situations.

Transferability

In transferability, A. K. Shenton emphasizes the significance of the studies communicating to the reader the limits and legitimate objectives of the research. Shenton. (2004). These boundaries and takes as used are described below (Shenton, 2004).

This study engaged 122 participants (respondents from 45 health facilities of the 15 counties in Liberia.

This research limited the data respondents to solely data specialists and health personnel at the Ministry of Health and health facilities directly engaged in malaria disease implementations and data collection; these health personnel and data specialists are aged between 25 and 45 years.

The fieldwork engaged 15 research assistants and 122 data experts and health workers; an additional 32 senior officers and programme managers of the health ministries were also interviewed as participants during the exercise.

This study engaged a mixed data collection method that included quantitative and qualitative methods, qualitative engaged document review, focused group discussions, in-depth vital informants' interviews, direct participation and direct observation of practices. While the quantitative engaged and existing HMIS data collections and few questionnaires, desk reviews were performed for both methods.

The data collection sessions for the interview took approximately 1 hour and 20 minutes for each of the focused group discussions with an average of 15 participants per group, and the key informant interviews for key staff took approximately 1 hour; the questionnaire took 30 minutes each.

The whole data collection exercise lasted 12 weeks due to disruptions of holidays, official meetings and training at the Ministry of Health and facilities.

Dependability and conformity

Some scholars contend that comparable outcomes ought to be achieved if investigations were conducted again, within the same context, utilizing the same techniques and subjects, however, (Andrew, 2004) contended that the evolving characteristics of the phenomena explored by qualitative researchers make such stipulations challenging in their studies (Andrew, 2004). Nevertheless, this research showcased that the comprehensive insights collected through overlapping methodologies, like focus groups and individual interviews in detail will allow a future researcher to replicate the study and obtain the same findings.

Research design: This study adopted a systematic research approach and philosophical outlines in its plan to engage the malaria health information system of the Liberia Ministry of Health to produce reliable reports and recommendations. In its design,

the study employed a nonexperimental and mixed research approach due to the strength of clarifying nature and intentions of the research (Bryman, 2006).

The proposed Health Management Information System (HMIS) study with its set hypothesis relied on a mixed method approach (quantitative and qualitative) using an ethnography and case study design with a structured tool to engage the respondents; this becomes appropriate because using quantitative method allows broader respondents to be contacted (Earl, 2010). And the quantitative way provided participants with some level of freedom (e.g. using observation and interview) that permits naturalness, which will help reveal some individual issues and outliers that permit global view representation from the results (Adami & Kiger, 2005; Thurmond, 2001).

This also helped the study to triangulate information through influential data culture of best practice.

Triangulation in this study is to avoid any contradiction between these methods but instead focus on its sense of the possibilities of bringing techniques together to improve and shed light on any chosen social research study (Olsen, 2004). The triangulation approach will contribute to the overall quality of the research and facilitate the achievement of some articulated purpose" (Adami & Kiger, 2005). The primary triangulation method that will be dependent on is methodological triangulation, which is the combination of qualitative and quantitative approaches that enable the most effective portrayal of global perspectives (Casey & Murphy, 2009; Adami & Kiger, 2005). And expresses how quantitative data can enhance studies by revealing outliers or unique individual cases of the study context (Adami & Kiger, 2005).

Data gathering: In the first part, Quantitative data was obtained from the outpatient and laboratory logs at the 45 health facilities, including the DHIS2 database and using structured checklists and rating scales known as Likert scales to rate data availability (Leedy and Ormrod, 2005). This data was collected for five years, and 2012 pre-Ebola was used as a baseline; it identified policy-relevant data such as the burden of malaria, diagnostic procedures, and treatment practices (Kunimitsu, 2009). Further, structured, in-depth developed interview tools (both face-faced and telephone - in the case of non-availability of some key respondents) for the key informants such as government personnel and implementation agencies were used. In this study, the data collection was more of both the researcher's presence and research assistants because of the nature of the country's data storage on the HMIS that must be extracted. Also, a structured questionnaire template was created to gather essential quantitative data from important health ministry personnel to assist in generating vital statistical components for analysis in the study (Coughlan, 2007).

In the second part, a cross-sectional observational study was conducted using the observation/participation technique for gathering data to determine the quality of documented and reported information. A participant-observer approach was employed for this part of the study; it was a covert method because data collection and validation were not carried out at one point, and ethical consideration was necessary.

This process is very important because it will determine if there is any significant difference in the malaria slide positivity rates among those suspected of having malaria that the clinical staff sends for testing compared to those not sent for testing. Furthermore, a qualitative interview tool with few questions was developed for in-depth recorded discussions with senior ministry staff and a focused group discussion with junior staff (data

clerks, field data collectors, HMIS county staff and HMIS central staff). This data collection process will help gather and allow key characteristics and natural occurrences amongst variables needed in this research (objectives 2 & 3), (Alexander, 2002). In the second part of this component, key informant interviews and document reviews were also used to gather information about historical antecedents and functionality of the health management information system. In addition to the key informants above, individuals who formerly occupied senior positions in the Ministry of Health were identified and approached.

This process showed data credibility, especially in taking a queue of experiences from another research. During the study an audit trail was engaged to ensure confirmability, further to unsure that research respondents are correctly presented moderately than just characteristics and preferences of the study researchers. This audit trail was carried out all through the processes and procedures of data collection that allow any research assistants to trace any cause or challenges that may research step-by-step study processes which could affect data decisions and research practices described in the data collection and analysis presented.

Reliability and validity of data

This consists of two parts and is designed to provide information on malaria data quality. In the first part, data extracted from the outpatient and laboratory registers at the six sentinel sites will be assessed to identify policy-relevant data such as the burden of malaria (the data here is just for quality check because they are already entered into the DHIS2 platform), diagnostic procedures and treatment practices. The HMIS reporting tools will also be reviewed to determine how much they capture the identified policy-relevant data.

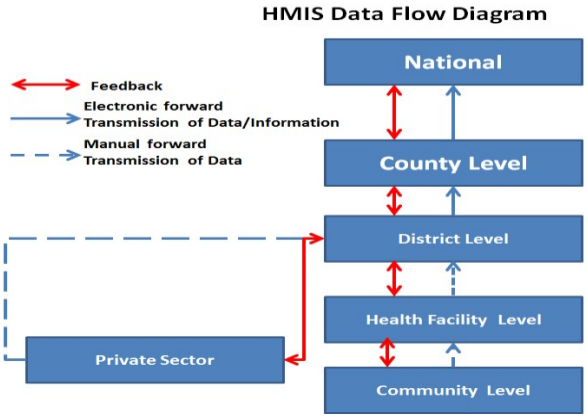
In the second part, a cross-sectional observational study will be carried out to determine the quality of documented and reported data. The study will determine any significant difference in the malaria slide positivity rates among those suspected of malaria that the clinical staff sends for testing compared to those not sent for testing. This would allow for an understanding of the impact of the diagnostic methods used by health workers on the epidemiological characteristics of malaria observed at the health facilities and the quality of the data produced, as indicated in Kunimitsu article. (Kunimitsu, 2009).

Results

A total of 128 respondents amongst data entry personnel (but 161 respondents, when added with other health officers as respondents) were selected, using a simple random process across 923 health facilities (850 HIS, data officers and data officers were available for selection) from 93 health districts and across the 15 counties. These health officers engaged for the study containing 47 health staffs have participated in facility-based investigation and 122 FGD research participants (with approximately 12 to 15 members per group); 9 facility managers (doctors), Pharmacy and phlebotomy technicians (13), Monitoring and Evaluation/data entry staffs (33), Community Health Officers (15), and Nursing Officers (15) of MOH and Health/Primary Health Care were interviewed. 11 of the PHC coordinators were also interviewed but questionnaires for the study were sent out to them prior to the filed work. Also, 2 tertiary, 14 secondary and 112 community health facilities and PHCs were assessed using both observational and interview instruments methods with use of data quality assessment tools amongst others.

Figure 2

HMIS Data Flow Diagram



As curled from (Liberia national Monitoring and Evaluation plan [M&E], 2016 – 2020).

Study results are outlined and presented in sections below as follows, primarily as they link with specific research objectives:

SECTION A: Socio-demographic characteristics of respondents

SECTION B: How was the HMIS developed and evolved in past five years?

SECTION C: How reliable and appropriate is the malaria HMIS data for malaria control decision making?

SECTION D: How has using HMIS data supported malaria prevention and control planning?

SECTION E: What are the expected determinants to effective HMIS strengthening for malaria control in the country?

SECTION A: Socio-demographic characteristics of respondents from the 15 counties and health facilities.

Figure 3

Respondents Gender

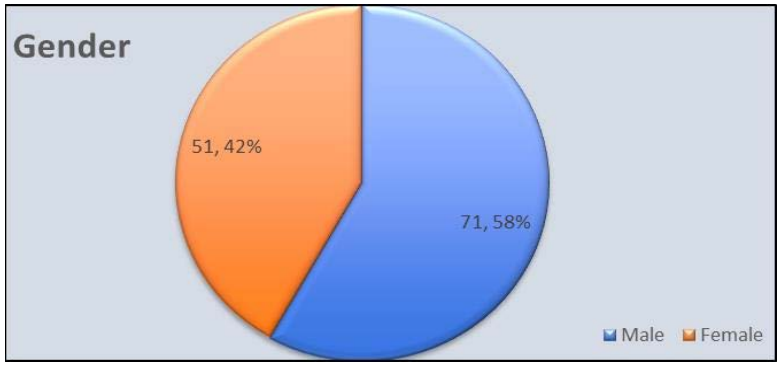
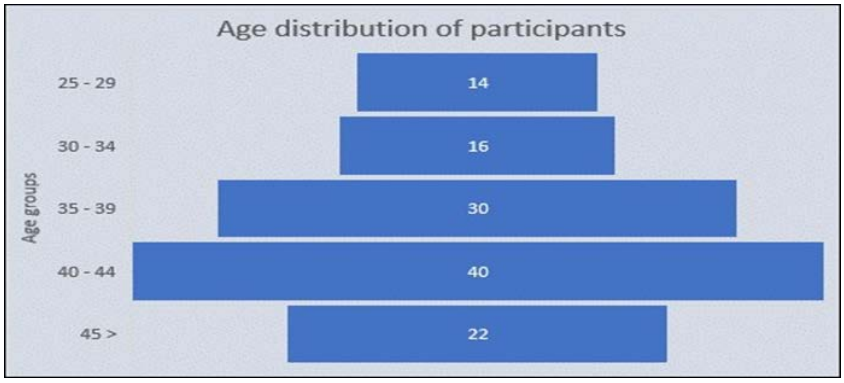


Figure 4

Age Distribution



Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
ages	23	828	36	46
distribution	23	122	5.304348	9.857708

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	10835.57	1	10835.57	387.9703	1.89E-23	4.061706
Within Groups	1228.87	44	27.92885			
Total	12064.43	45				

The baseline is National Malaria data captured from the HMIS platform between 2014 to 2018 (5 years) and 2012 (post-Ebola).

Table 7

Malaria Cases by Year

Year	All Malaria cases	percentage
2012	1,858,373	18%
2014	1,858,373	18%
2015	1,674,118	17%
2016	1,827,956	18%
2017	1,462,530	14%
2018	1,432,797	14%
Total	10,114,147	100%

The table above, indicates malaria disease trend in Liberia using a five-year trend of 2014 to 2018. This study has put into considerations 2012 as a base to compare with the pre-Ebola period, however an extended was also reviewed as the case arises.

Data capture

Respondents

This research was conducted through a mixed method and tools comprising of IDIs, KIIs and FGDs (both quantitative and qualitative). The 122 FGDs were conducted in the sampled 138 health facilities across the counties, while the IDI was conducted with 96 M&E and data personals across the health districts and 47 KII was conducted strictly with senior cadre of the health ministry. Also, these includes: 2 tertiary institutions, 14 secondary facilities, 112 community health facilities and PHCs were assessed using both observational and interview instruments methods.

Quantitative data

The primary data is derived from the national HMIS database for malaria and analyzed with the SPSS package.

Qualitative data

The primary data is derived through In-depth Interview (IDIs), Key Informant Interview (KII), observations and Focused Group Discussion (FGDs).

For the **KII** the respondents are:

Senior Ministry of Health directors

Health information system unit directors

Malaria control directors

Monitoring and evaluation directors

In-depth Interviews (IDI)

Data managers (DM) from the health districts and Ministry of health

Data clerks (DC), HMIS officers, etc. – (facility data entry staff)

Health facility managers (PM) – in charge

Health facility supervisors (PC) and coordinators

Focused Group Discussions (FGDs) had participants from:

Ministry of Health

The county health departments at the

Tertiary Hospital (university and teaching hospitals) e.g. JFK hospital Monrovia

Secondary facilities (General hospitals)

Primary Health Centres (PHC)

Primary Health Care Boards

Health Management Information System Unit (HMIS-U)

Maternal and Childcare department of the health facilities

Data Entry

Already transcribed data was imported from Microsoft Excel into NVIVO. The spreadsheet was aligned so that NVIVO can run the query based on cases (questions) in the columns and classifications (category of participants) by rows. The responses were recorded under each question known in NVIVO as cases. The classification of the respondents was based on their positions/roles for the KII and their institutions for the FGDs

Data analysis

Qualitative: After data entry and audit, running queries of word frequencies and word cloud on NVIVO derived the findings from the qualitative survey. The software was also used to generate reports of the specific questions exported to MS Word to enable interpretation and report writing. Boyatzis, R. E. (1998).

Quantitative: The generated national malaria data from health facilities (primary, secondary, and tertiary) is entered into the District Health Information system from facilities, entered through the HMIS platform/tools. This data was collected and recorded on Ms excel spreadsheet, then exported to the SPSS software for analysis.

The analysis is described under the four research questions.

SECTION B: How was the HMIS developed and evolved in past five years?

Research question 1/Hypothesis

1. **RQ:** How was the HMIS developed and evolved in the past five years?
   Ho: The developed health management information system is not reliable and appropriate for malaria control decision-making

Ha: The developed health management information system is reliable and appropriate for malaria control decision-making.

Table 8

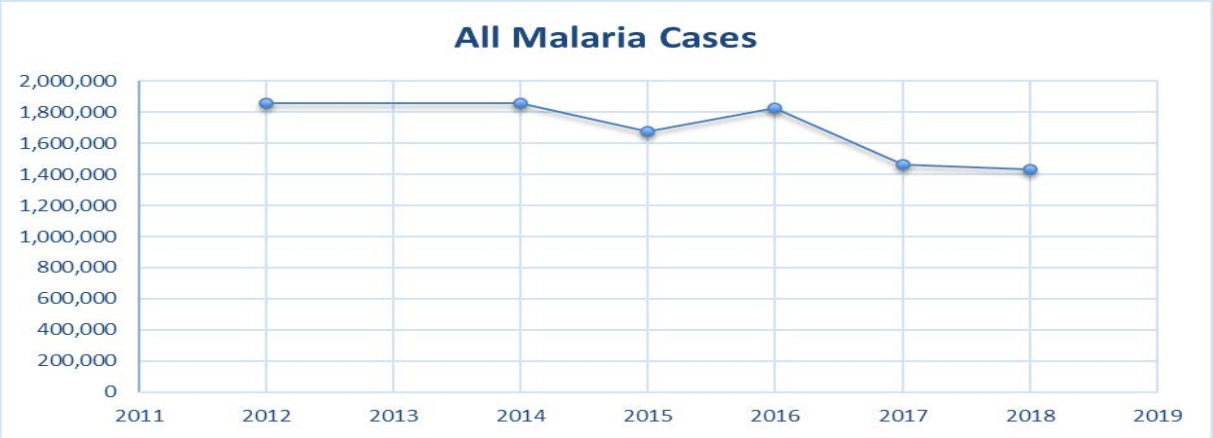
Malaria Trend in the Last 5 Years

	2012 Malaria Cases	*2014 Malaria Cases*	*2015 Malaria Cases*	*2016 Malaria Cases*	*2017 Malaria Cases*	*18 Malaria Cas*
Mean	154864	154864	139510	152330	121878	119400
Standard Error	5567	5567	9492	5935	4179	3792
Median	155910.5	155910.5	137341	152494	125325	119046
Standard Deviation	19283	19283	32881	20561	14476	13135
Sample Variance	371842472	371842472	1081176391	422758557	209558465	172522294
Kurtosis	0.788	0.788	-1.921	-0.334	-0.915	-0.502
Skewness	-0.908	-0.908	0.178	-0.092	-0.203	0.485
Range	68490	68490	79986	67516	45620	41982
Minimum	114331	114331	102835	116331	100665	102821
Maximum	182821	182821	182821	183847	146285	144803
Sum	1858373	1858373	1674118	1827956	1462530	1432797
Count	12	12	12	12	12	12
Largest (1)	182821	182821	182821	183847	146285	144803
Confidence Level (95.	12251.97179	12251.97179	20891.7475	13063.89541	9197.696948	8345.437386

In the SPSS malaria analysis table trend of the last 5 years shown above, 2012 is the Baseline Year – Pre-Ebola. Also, represented in the chart below.

Figure 5

Malaria Trend (Cases)



A simple trend analysis and frequency was engaged in attempt to measure or spot a pattern of data and diseases, this attempts to predict futuristic data collection and use across years. Further the trend analysis is important to this research because it provides a scientific calculation/trend movement for identifying and predicting future trends and outcome.

Figure 6

Malaria Trend Cases analysis

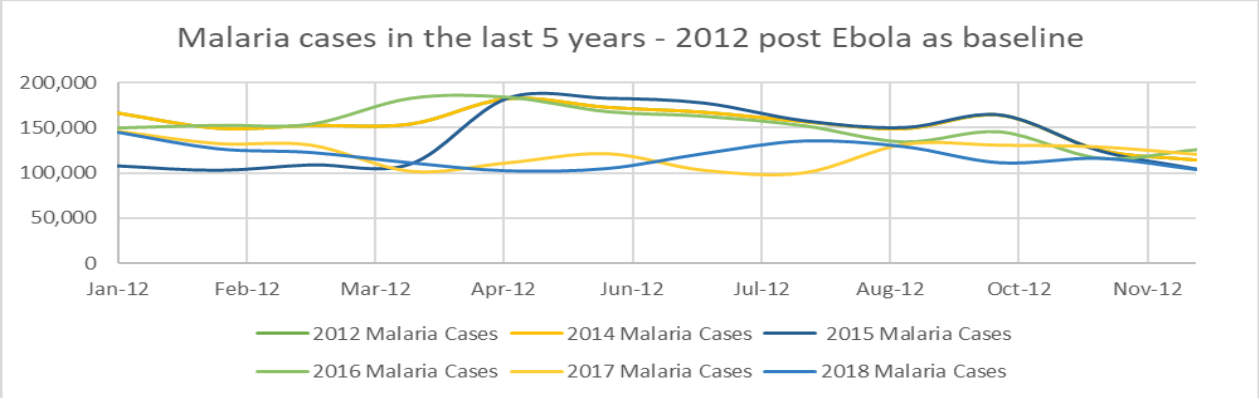
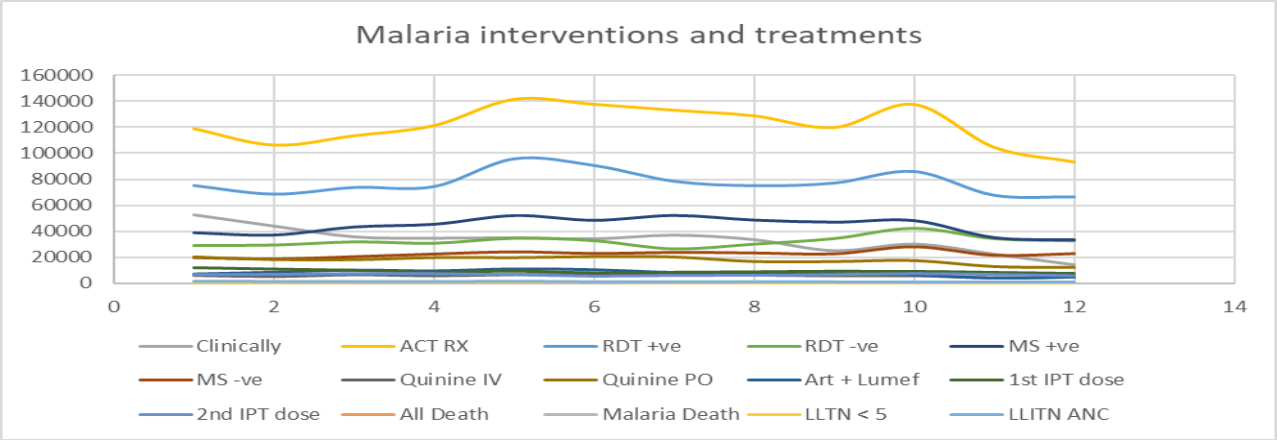


Figure 7

The Malaria Trend (Cases Analysis)



The Malaria Cases analysis trend for 2015 and 2017 showed a later drop in malaria disease

The charts above show a frequent data collection trend through the use of the country health HMIS platform; there was a disruption to the county's health intervention system during the Ebola crisis in Liberia between 2013 and early 2014 that took a very tough but rapid recovery process.

Qualitative: The sentiments and themes are captured in the findings below; this is captured through the structured interview questions.

Interviews &FGDs

- Briefly describe the health system data collection process.
- What data collection tools are used in the data collection process at every level of facilities?
- What platform(s) are used for data storage and management?
- Do you have partners supporting health data management in the health sector?
- What is the partner's role in data management?

The words mentioned the most are captured in the cloud below. Boyatzis. (1998).

Cloud 1

Respondents Analysis

"There was a unanimous response that the health system uses the HMIS tools to collect data and report on the DHIS2 platform, which serves both visualization and storage purposes for the country's malaria data".

"The participants acknowledged the partnerships and support from donor partners to enhance the institutional and human capacity in using HMIS tools and payment of salaries".

SECTION C: How reliable and appropriate is the malaria HMIS data for malaria control decision making?

Research question 2/Hypothesis

2. **RQ:** How reliable and appropriate is the malaria HMIS data for malaria control decision-making?

   Ho: The health management information system has not been pictured and used correctly.

Ha: The health management information system has been pictured and used correctly.

Reliability and appropriateness were measured through the data and HMIS/DHIS2 efficiency questions.

Efficiency

- How would you rate data performance and demand so far?
- What has been done with data in the country, or how will you describe data used for health systems decision-making?
- What do you think can be done better?

"The data managers are particularly explanatory that the data has helped get a clear picture of malaria incidence in the different counties and what interventions have been working in their response".
"*However, the project managers and supervisors would like reduced transcription errors during data entry and timely data entry for quick decision making"*. Data managers from HFs

One of the data managers said, "*The data team have done well in entering data but can do better in the area of timeliness of entry*".

On the challenge of transcription errors from HMIS tools to the DHIS2 platform, a data manager said, "*The data team has challenges with transcription errors from HMIS tools to DHIS2 but had done well with data entry on DHIS*".

This feedback underscores the areas that need improvement while acknowledging the HMIS system's positive impact in strengthening the country's malaria program.

Cloud 2

Respondents Analysis

Word frequency for data performance rating by participants

SECTION D: How has using HMIS data supported malaria prevention and control planning?

Research question 3/Hypothesis

3. **RQ:** How has using HMIS data supported malaria prevention and control planning?

   Ho: Decisions on Malaria prevention and control has not been made through the use of valid HMIS data

   Ha: Decisions on Malaria prevention and control have been made using valid HMIS data.

   Using the HMIS data and the support for malaria prevention was measured through the effectiveness questions.

Effectiveness

- Have the data management objectives for decision-making been achieved and on time?
- Were there some challenges or successes that influenced the achievement or non-achievement of the health information system?

The FGD response noted, "*There is still an extensive journey ahead in accomplishing the goals of utilizing data for decision-making.*".

"*Most of the data managers mentioned that there has been a remarkable achievement, but the objective has only been achieved at an estimated 50%*".

"*The sentiments of the project managers and supervisors are somewhat negative, especially around the weak capacity of the data officers (clerks) and the difficulty in paying their salaries*".

"*They believe these are key factors slowing down the growth rate in providing quality and timely data through the HMIS*".

"There appears to be a narrow view to the significance of data and its application; the majority of the respondents across the classifications highlighted that the main use of data is to help the country develop a proposal for funding from donor partners".

The country may need to show more commitment in using these data to identify success factors and gaps in the intervention of malaria and adapt the same for other health programs that have national priority.

Table 9

Tree Map for HMIS Data Use in the Health Sector

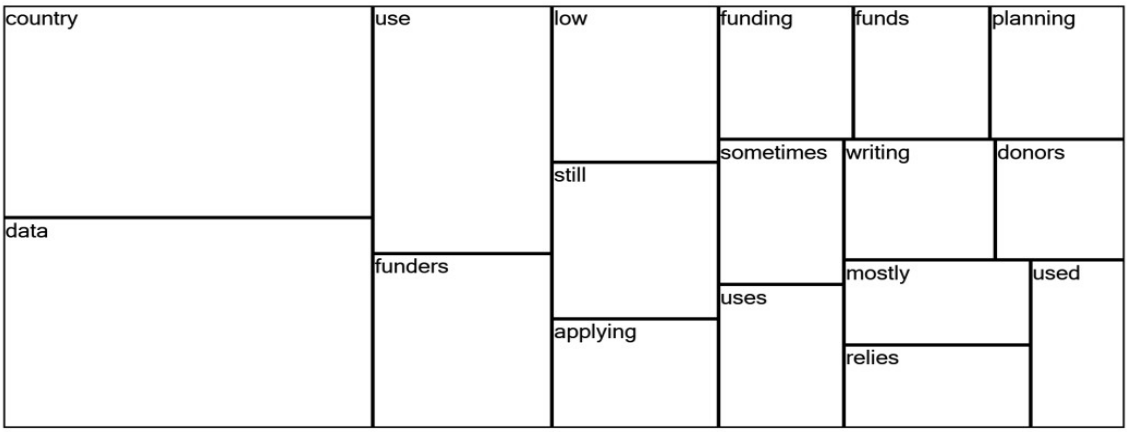
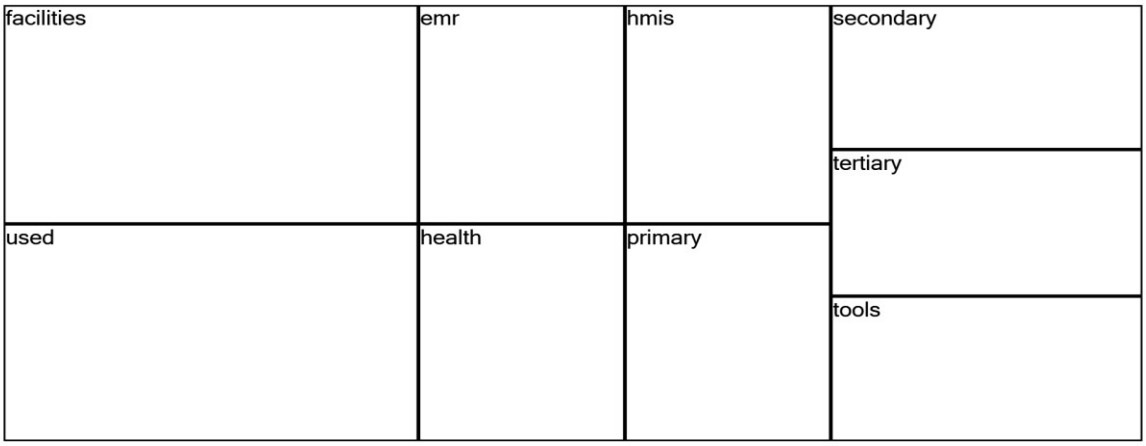


Table 10

Tree Map for HMIS Challenges in the Health Sector



SECTION E: What are the expected determinants to effective HMIS strengthening for malaria control in the country?

Research question 4/Hypothesis

4. **RQ:** What are the supportive determinants to effective HMIS strengthening for malaria control in the country?

   Ho: Decisions on Malaria prevention and control has not been made through the use of valid HMIS data

Ha: Decisions on Malaria prevention and control have been made using valid HMIS data.

The supportive determinants are measured through the sustainability and Impact questions.

Sustainability

- *How has the health information system improved the technical skills/capacity of the health structure?*
- *What were the significant factors that influenced the achievement or non-achievement of sustainability of the health information system?*

"*Participants affirmed that the unified reporting system is a notable benefit that the HMIS brings to malaria programming"*.

This indicates that the country has taken ownership of the system but needs to do more to improve human capacity and have a more robust justification for using malaria data in country.

Impact

- *What real difference has the health information system made to the health system?*
- *What has happened due to the excellent/weak/flawed health information system?*

According to the participants, "*HMIS has engendered a unified reporting system idea. It has also helped the program managers and government institutions to plan malaria interventions better"*.

According to one of the project supervisors, ***"The Health information system has built a way for data demand and use for planning".*** The HMIS has increased data demand and provided direction for health interventions.

Cloud 3

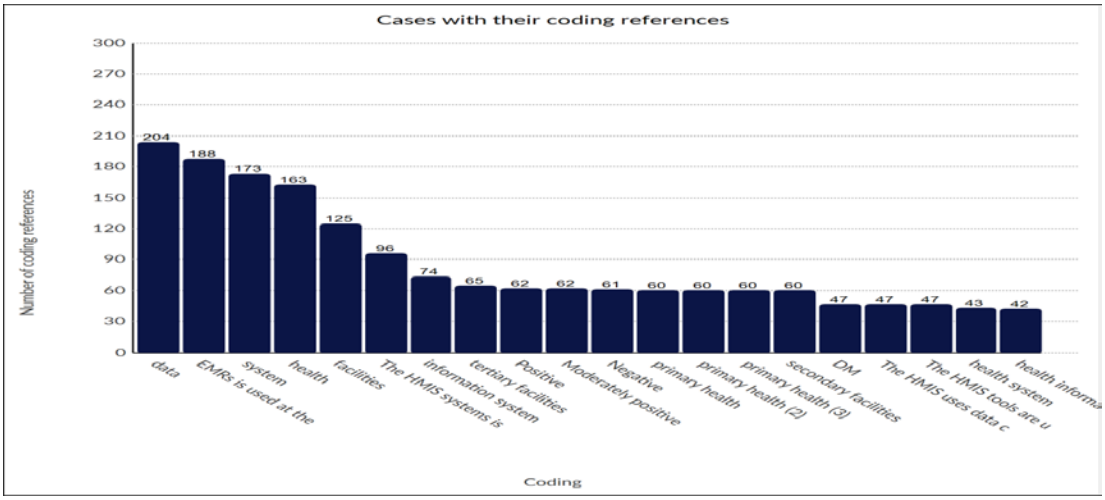
Word Count for the Effect of Weak or Strong Health Information Systems

Table 11

Tree Map of How HMIS has made a Difference in the Health Sector

Figure 8

References For Codes Across Different Cases and Classifications



This table shows the most referenced words and the sentiments expressed by the participants during the key informant interviews and focus group discussions.

Coud 4

Word Count for Recommendations

Evaluation of Findings

Health system and information management (Data analysis and findings)

This research sought to gain insights into the progression and operation of the health system and its information significance to decision-making associated with health planning, particularly concerning malaria prevention and control in Liberia.

This study on Liberia health system focuses on malaria control program that is coordinated by Liberia MOH through donor-supported programs, as seen from the responses and interventions in the 15 counties with 136 districts and communities (though the study was done in 122 facilities across the 136 districts). Malaria interventions take place at facilities (both government and non-government facilities), and diagnosis could be Microscopy (Lab) and clinical (Random test). Random tests could be at the facilities or community levels, including private organizations such as pharmacies. This was observed as described in the Liberia National Demographic Health Survey (LDHS, 2013).

In its findings, this study is expected to provide evidence on 1) why HMIS and evidence-based decision-making remain weak, 2) how the data system can be strengthened sustainably to improve health systems and reduce mortality rates through evidence-based planning and interventions.

Further, the study results from the literature is expected to provide a body of knowledge on why health systems and their information management that controls decisions making through key data evidence remain weak.

The research question and Hypothesis were developed to further strengthen the study outcome and recommendations; this is outlined below:

Research questions

Q1. How has the HMIS developed and has evolved in the past five years?

Q2. How appropriate is the malaria HMIS data for malaria control decision-making?

Q3. How has the use of HMIS data supported planning in malaria prevention and control?

Q4. What are the expected determinants to effective HMIS strengthening for malaria control in the country?

The analysis is described under the four research questions.

Quantitative analysis:

How has HMIS evolved in the past five years?

Hypothesis

Ho: The developed health management information system is not appropriate for malaria control decision-making

Ha: The developed health management information system is appropriate for malaria control decision-making

This study generated malaria data from different sources and facilities in Liberia, including consultation, hospital diagnoses, rapid community testing, etc. Through teaching hospitals, secondary health facilities, primary healthcare centres and communities. This includes the Liberia (HPF, 2007), National Health Plan [NHP], 2007-2011) and current data populated through HMIS tools to the DHIS2 platform.

Within the Liberia healthcare sector and Malaria control, data are generated from the text recorded at community and facility levels, either structured or unstructured. Looking at the structured aspect, data are collected and classified to be significant and guided decision made at various levels of healthcare services. From the study responses, it was observed that some data were considered more serious and important to track than others, such as data that determine mortality and morbidity, agreeing with the argument of Iyamu and Mgudlwa. (2018), which explained why and how data is employed and reasons behind the usefulness in harnessing data benefits linking to both technical and human factors during the study.

Malaria trend in the last five years (2012 is the baseline year – Pre-Ebola)

Table 12

Malaria Trend and Analysis

2012 Malaria Cases	*2014 Malaria Cases*	*2015 Malaria Cases*	*2016 Malaria Cases*	*2017 Malaria Cases*	*18 Malaria Cas*
Mean	154864	154864	139510	152330	121878	119400
Standard Error	5567	5567	9492	5935	4179	3792
Median	155910.5	155910.5	137341	152494	125325	119046
Standard Deviation	19283	19283	32881	20561	14476	13135
Sample Variance	371842472	371842472	1081176391	422758557	209558465	172522294
Kurtosis	0.788	0.788	-1.921	-0.334	-0.915	-0.502
Skewness	-0.908	-0.908	0.178	-0.092	-0.203	0.485
Range	68490	68490	79986	67516	45620	41982
Minimum	114331	114331	102835	116331	100665	102821
Maximum	182821	182821	182821	183847	146285	144803
Sum	1858373	1858373	1674118	1827956	1462530	1432797
Count	12	12	12	12	12	12
Largest(1)	182821	182821	182821	183847	146285	144803
Confidence Level (95.	12251.97	12251.97	20891.74	13063.89	9197.69	8345.43

Simple trend analysis and frequency were engaged to measure or spot a pattern of data and diseases, this attempts to predict futuristic data collection and use across years. Further, trend analysis is important to this research because it provides a scientific calculation/trend movement for identifying and predicting future trends and outcomes.

Table 13

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.845511221
R Square	0.714889225
Adjusted R Square	0.6198523
Standard Error	0.974868837
Observations	5

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	7.148892252	7.148892252	7.522225975	0.071178724
Residual	3	2.851107748	0.950369249		
Total	4	10			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2027.10707	4.073132265	497.6776933	1.78904E-08	2014.144545	2040.07	2014.145	2040.07
1858373	-6.72685E-06	2.45267E-06	-2.742667675	0.071178724	-1.45323E-05	1.08E-06	-1.5E-05	1.08E-06

RESIDUAL OUTPUT

Observation	*Predicted 2012*	*Residuals*	*Standard Residuals*
1	2014.606074	-0.606074313	-0.717875379
2	2015.84553	-0.845530005	-1.001502884
3	2014.810685	1.1893151	1.408705186
4	2017.268851	-0.26885068	-0.318444916
5	2017.46886	0.531139898	0.629117993

PROBABILITY OUTPUT

Percentile	*2012*
10	2014
30	2015
50	2016
70	2017
90	2018

year 2012	2012 Malaria Cases	year 2014	2014 Malaria Cases	year 2015	2015 Malaria Cases	year 2016	2016 Malaria Cases	year 2017	2017 Malaria Cases	year 2018	2018 Malaria Cases
2012-01-01	166,803	2014-01-01	166,803	2015-01-01	107,803	2016-01-01	149,825	2017-01-01	146,285	2018-01-01	144,803
2012-02-01	149,835	2014-02-01	149,835	2015-02-01	102,835	2016-02-01	152,702	2017-02-01	132,711	2018-02-01	126,835
2012-03-01	152,854	2014-03-01	152,854	2015-03-01	108,956	2016-03-01	154,055	2017-03-01	131,055	2018-03-01	122,854
2012-04-01	154,535	2014-04-01	154,535	2015-04-01	109,976	2016-04-01	182,722	2017-04-01	102,347	2018-04-01	111,535
2012-05-01	182,821	2014-05-01	182,821	2015-05-01	182,821	2016-05-01	183,847	2017-05-01	111,667	2018-05-01	102,821
2012-06-01	173,203	2014-06-01	173,203	2015-06-01	182,803	2016-06-01	167,880	2017-06-01	121,675	2018-06-01	105,431
2012-07-01	167,660	2014-07-01	167,660	2015-07-01	177,550	2016-07-01	162,768	2017-07-01	103,442	2018-07-01	121,660
2012-08-01	157,286	2014-08-01	157,286	2015-08-01	157,998	2016-08-01	152,286	2017-08-01	100,665	2018-08-01	135,286
2012-09-01	149,247	2014-09-01	149,247	2015-09-01	150,247	2016-09-01	134,363	2017-09-01	131,779	2018-09-01	129,247
2012-10-01	164,363	2014-10-01	164,363	2015-10-01	164,363	2016-10-01	145,435	2017-10-01	130,986	2018-10-01	111,672
2012-11-01	125,435	2014-11-01	125,435	2015-11-01	124,435	2016-11-01	116,331	2017-11-01	128,975	2018-11-01	116,432
2012-12-01	114,331	2014-12-01	114,331	2015-12-01	104,331	2016-12-01	125,742	2017-12-01	120,943	2018-12-01	104,221
Total	**1,858,373**		**1,858,373**		**1,674,118**		**1,827,956**		**1,462,530**		**1,432,797**

Period	Total All Cases	All Mal. Cases	Clinically	ACT RX	RDT +ve	RDT -ve	MS +ve	MS -ve	Quinine IV	Quinine PO	Art + Lumef	1st IPT dose	2nd IPT dose
January 2012	342495	166803	52705	118979	75322	29120	38776	19687	6255	20695	7505	12193	6790
February 2012	306514	149835	44077	106433	68731	29508	37027	18720	5368	18577	8792	11191	7039
March 2012	342255	152854	35841	113624	73823	31923	43190	20416	6790	18497	10402	10270	7572
April 2012	382103	154535	34798	121414	74527	30856	45210	22465	5953	20137	9821	8875	7514
May 2012	373843	182821	35148	141538	95792	34596	51881	24129	6907	20109	11328	9628	6856
June 2012	353291	173203	34278	137699	90682	32757	48243	22893	6991	20901	10698	8361	5667
July 2012	355982	167660	37132	133152	78565	26618	51963	23694	6840	20593	8646	8809	6214
August 2012	389145	157286	33692	128868	75168	30198	48426	23274	6440	17116	8260	9121	6361
September 2012	285662	149247	25210	119897	77215	34369	46822	22569	5908	17067	7893	9559	6880
October 2012	2895	164363	30240	137588	86093	42084	48030	28003	6037	17854	6853	9414	7548
November 2012	2177	125435	22501	104761	67861	34317	35073	21514	4065	13207	4534	8660	6971
December 2012	2792	114331	14327	93449	66631	32635	33373	22771	4827	12535	5268	7866	6017
Total	**3139154**	**1858373**	**399949**	**1457402**	**930410**	**388981**	**528014**	**270135**	**72381**	**217288**	**100000**	**113947**	**81429**

Mean	261,596	154,864	33,329	121,450	77,534	32,415	44,001	22,511	6,032	18,107	8,333	9,496	6,786
Sd Dev	152,085	18,462	9,452	14,370	8,679	3,723	6,178	2,286	862	2,683	2,006	1,170	591
Max	389145	182821	52705	141538	95792	42084	51963	28003	6991	20901	11328	12193	7572
Min	2177	114331	14327	93449	66631	26618	33373	18720	4065	12535	4534	7866	5667

Figure 9

Malaria Trends and Cases Across the Years in Liberia

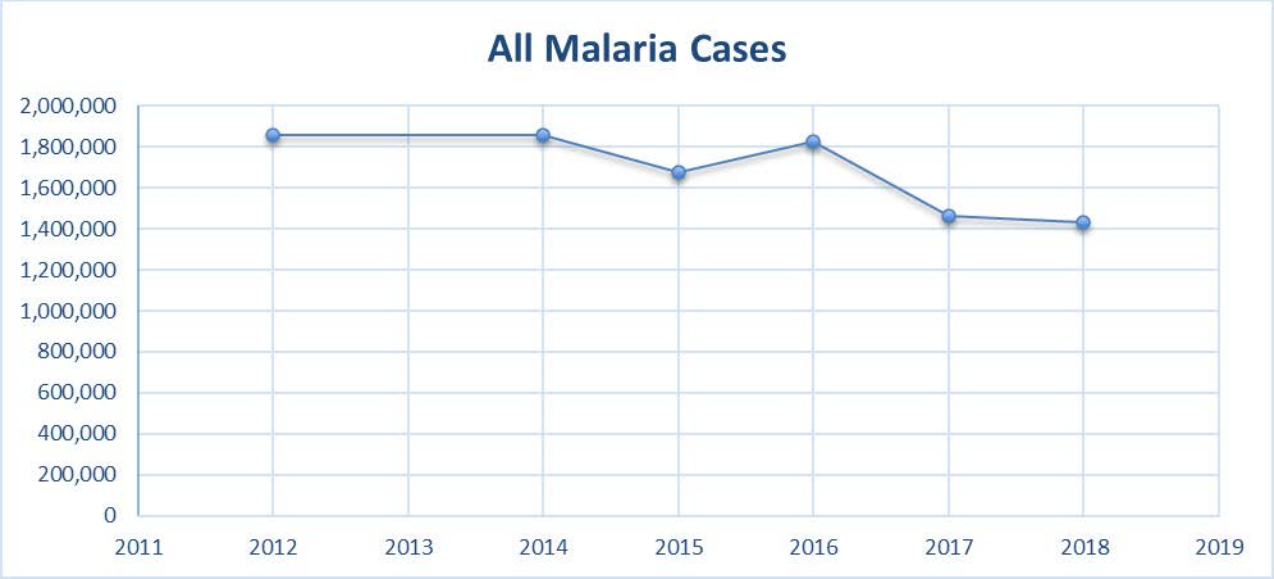
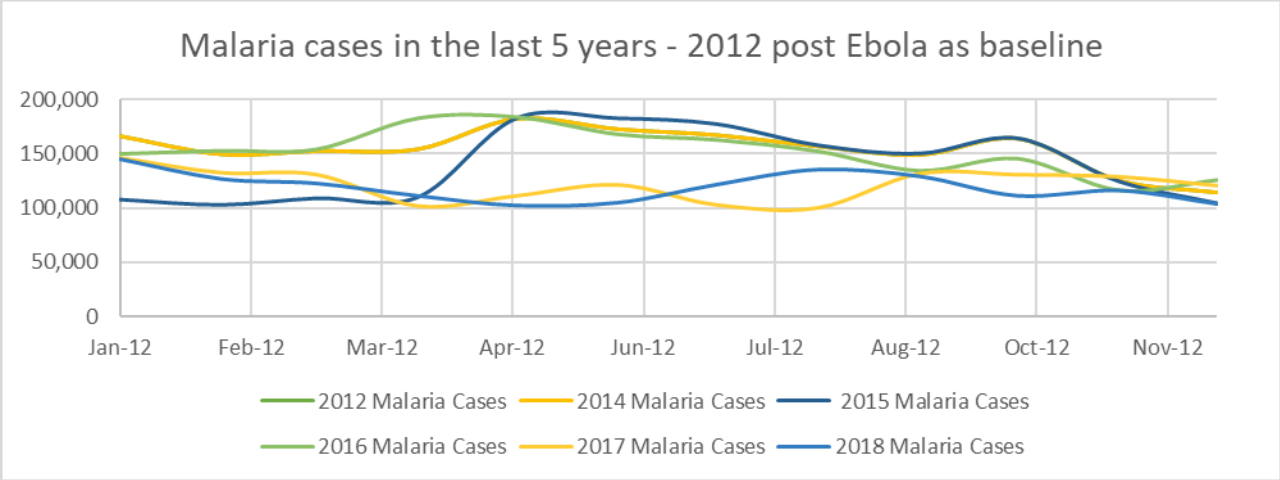


Figure 10

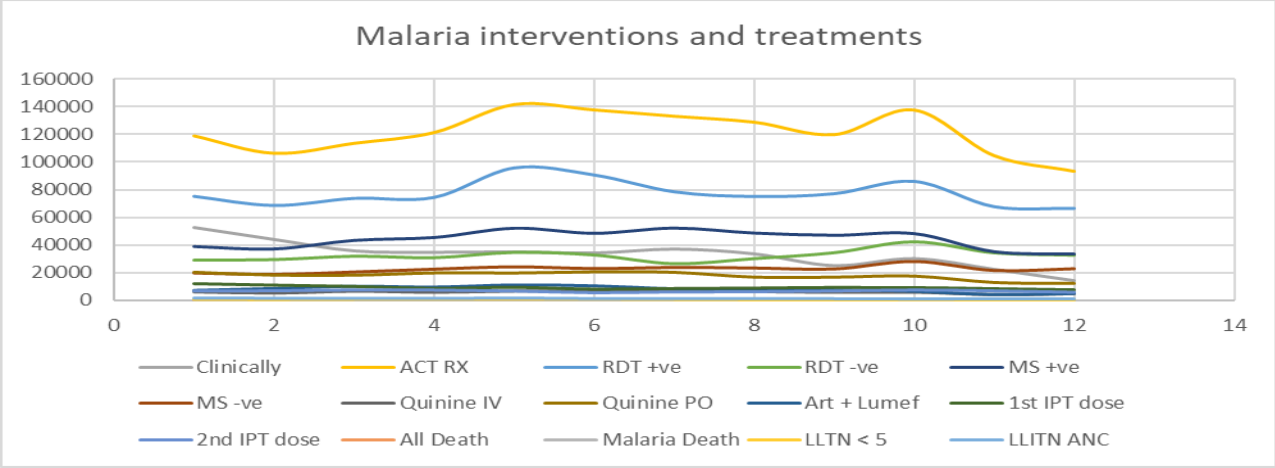
Liberia Malaria Trends and Cases Across the Years



2015 and 2017 showed a drop in the malaria disease.

Figure 11

Country Malaria Trend (Cases analysis)



The charts above show a frequent data collection trend through the use of a country HMIS platform (2015 and 2017 showed a drop in the malaria disease through improved

treatments); there was recorded health system disruption during the Ebola crisis in Liberia between 2013 and early 2014.

From Table 1 above, The 95 C.I show and the <1 skew-ness using a simple trend analysis show a significance in the application of malaria data for the health system and planning in Liberia with a variance of 4 and below across the years, thus the rejection of the null Ho: The developed health management information system is not reliable and appropriate for malaria control decision-making and therefore the alternative hypothesis H1 is accepted, that is: The developed health management information system is reliable and appropriate for malaria control decision making.

This means there are frequent malaria data collection processes across the health systems in all the counties, strengthening the data systems and demonstrating dependability for malaria management and will assist in data organization. The data gathering procedure within the health framework has remained reliable throughout the years but experienced a decline in 2013 because of the Ebola virus interruptions in the health framework.

Qualitative Analysis:

The sentiments and themes are captured in the findings below; this is captured through the structured interview questions.

Table 14

Key Informant Interviewer's Synthetic Analysis (Quantitative Response)

	Questions	Respondents	Responses				Number of respondents
1	Briefly describe the health system data collection process.	Data manager group 1	The HMIS tools are used in the almost all disease areas including the malaria program	Data manager group 2	The HMIS uses data collection tools is used 100% at the district levels and transferred into the DHIS2 platform	Data manager group 3	The malaria program uses HMIS data collection tools majorly at the district levels and transferred into the DHIS2 platform
		Data managers group 5	The HMIS systems is used in the 3 diseases (malaria, HIV and TB program)	Data managers group 5	EMRs is used at the tertiary facilities but transferred to the DHIS2 at the central level	Data manager group 6	EMRs is used at the tertiary facilities but transferred to the DHIS2 at the central level but the DHIS is used across board
		Data managers group 7	The DHIS2 and EMRs are utilized at the healthcare facilities; however, the EMR is conveyed to the DHIS2 at the central level.	Data managers group 8	The HMIS is used at the tertiary, secondary and primary health facilities but transferred to the DHIS2 at the central level	Data manager group 9	The EMRs is used at the health facilities is the HMIS that is now transferred to the DHIS2 at the central level
		Data managers group 7	The HMIS systems is used in the 3 diseases (malaria, HIV and TB program)	Data managers group 9	The HMIS systems is the major health data system and used in the 3 diseases (malaria, HIV and TB program)		
		Project managers group 1	The HMIS systems is the main data systems for all in Liberia	Project managers group 2	The country uses the HMIS systems for the 3 key diseases (malaria, HIV and TB program)	Project manager group 3	The HMIS systems is the main database used in the Liberia diseases interventions
		Project managers group p4	The DHIS2 systems is used in the 3 diseases (malaria, HIV and TB program) and other disease areas	Project managers group 5	The HMIS systems is used in Liberia to collect diseases data that includes malaria, HIV, Immunization and TB program.	Project manager group 6	The Liberia health system and database is the HMIS systems that feeds into the DHIS2 through the HMIS
		Project managers group 7	The DHIS2 instance is the systems used in Liberia to collect diseases data across malaria, HIV, Immunization and TB program.				
		project supervisors group 1	The HMIS systems is used in Liberia to collect diseases data that includes malaria, HIV, Immunization and TB	project supervisors group 2	The data system in Liberia is the DHIS2 but data is collected through the HMIS tools for disease data	project supervisors group 3	The HMIS systems is used in Liberia to collect diseases data and moved into the

			program and flows into the DHIS2 platform		that includes malaria, HIV, Immunization, and other community interventions.		DHIS2 instance of the national database. This includes the 3 major diseases like malaria, HIV and TB
		project supervisors group 4	The interventions disease data in Liberia is collected mainly through the HMIS tools and transferred into the DHIS systems; these data is collected from malaria, HIV, Immunization and TB program.	project supervisors group 5	The HMIS and DHIS2 systems is used in Liberia as the main diseases intervention (malaria, HIV and TB program) database.	project supervisors group 6	Data is gathered via the HMIS and DHIS2 systems within the country. as the main database aside the EMRs at the tertiary and secondary health facilities.
		project supervisors group 7	Liberia uses the HMIS tools systems and the DHIS2 to collect, store, analyze and transfer disease data	project supervisors group 8	The HMIS and DHIS2 systems utilized by the ministry of health are the data systems implemented for the three diseases (malaria, HIV, and TB program).	project supervisors group 9	The Liberia National HMIS systems is responsible for collection and storage of key national diseases including malaria, HIV and TB.
		project supervisors group 10	The Liberia health system is currently using the DHIS2 database through the HMIS systems.				
		Data clerks group 1	The health system data collection process that feeds into the database is the HMIS systems that feeds into the DHIS2 with the HMIS tools	Data clerks group 2	The health system data collection and transfer processes and the database are all under the HMIS systems that feeds into the DHIS2 using HMIS tools	Data clerks group 3	The Liberia health system data and database storage is the HMIS systems that feeds into the DHIS2.
		Data clerks group 4	The health ministry utilizes the EMR, HMIS, and the DHIS2 health data systems. and database are the HMIS systems that feeds into the DHIS2 through the HMIS	Data clerks group 5	The health data system used in Liberia ministry of health at data collection points and storage is the HMIS systems that feeds into the DHIS2		
2	What data collection tools are used in the data collection process at every level of facilities?	Data manager 1	The HMIS tools are used at primary health & secondary facilities and EMR is used at tertiary facilities	Data manager 2	The HMIS tools are used at all health facilities including primary, secondary & tertiary facilities.	Data managers 3	The HMIS tools are utilized in every ministry of health institution, which encompasses primary, secondary, and tertiary facilities. Additionally, EMRs are employed in certain secondary

							and tertiary institutions.
		Data managers 4	The electronic medical records (EMR) and the HMIS tools are utilized at the ministry of health's primary, secondary, and tertiary facilities in Liberia.	Data managers 4	The HMIS tools are being used at primary, secondary and tertiary health facilities including the EMR at the tertiary facilities	Data managers 5	The HMIS tools serve as the primary recognized intervention asset for malaria, HIV, and TB utilized at the health facilities governed by the ministry. It encompasses primary, secondary, and tertiary facilities. The EMR is additionally employed in certain advanced facilities.
		Data managers 6	The tools of the HMIS from the ministry of health are the authorized instruments utilized in primary, secondary, and tertiary health facilities. The EMR is likewise employed at tertiary facilities.	Data managers 7	The HMIS tools and the Community Based Information System (CBIS) tools are used at the communities, primary, secondary and tertiary health facilities.	Data managers 8	The ministry of health's provided HMIS tools are the approved tools used at primary, secondary and tertiary health facilities. Including EMR and the CBIS at the community and tertiary health facilities.
		Data managers 9	The HMIS tools and CBIS tools are used at health facilities to collect and transfer data at the community, primary, secondary and tertiary facilities in Liberia				
		Project managers 1	The health facilities governed by the Ministry of Health (MoH), which encompasses all government establishments along with a few private health universities, utilize the endorsed CBIS, EMR, and HMIS instruments.	Project managers 2	The HMIS tools that includes CBIS, and some excel databases are used at primary health, secondary and tertiary facilities including EMR at tertiary facilities	Project managers 3	The HMIS and CBIS are major tools used at government health facilities, this includes tertiary, secondary, primary and community health care facilities.
		Project managers 4	The HMIS tools are the broader instruments that are utilized at the healthcare facilities as authorized by the Ministry of Health (MOH);	Project managers 5	The HMIS tools that leads to the DHIS2 instance is the approved tools by the ministry of health	Project managers 6	The most well-known data collection instrument is the HMIS tools that

			this influences primary healthcare, tertiary, and secondary facilities.		used at the communities, primary health & secondary facilities.		are utilized at every health facility in the country, comprising public and several private facilities.
		Project managers 7	The HMIS tools are used at primary health & secondary facilities to collect, collate and transfer data to the DHIS2 platform in the country.				
		project supervisors 1	The HMIS tools are the instruments for gathering data employed at all levels of health facilities within the country; they are utilized at primary health, secondary facilities, and tertiary facilities, although some additional EMR tools are also implemented.	project supervisor s 2	The EMR, excel data base and HMIS tools are used at the health facilities but the HMIS tools for onward transfer to the DHIS2 is more recognised and approved by the ministry of health.	project supervis ors 3	At the healthcare establishments that encompass primary healthcare services within the community, primary healthcare, and secondary facilities, as well as tertiary healthcare facilities. The HMIS tools are utilized and transitioned to the DHIS2 platform.
		project supervisors 4	The accepted and recognised or approved national tools for data collection is the HMIS tools, they are used at primary health & secondary facilities, but the EMR is used at tertiary facilities	project supervisor s 5	The HMIS tools are used at primary health & secondary facilities and EMR is used at tertiary facilities	project supervis ors 6	The HMIS tools are the main and accepted tools used at health facilities, this are the primary health, secondary facilities and tertiary facilities
		project supervisors 7	The data gathering tools utilized throughout the nation at the community level, as well as at primary, secondary, and even tertiary health facilities, are the HMIS tools.	project supervisor s 8	The HMIS tools are used at primary health & secondary facilities and tertiary facilities, even though excel database and other EMR are used at facilities too.	project supervis ors 9	The HMIS tools, EMR and Microsoft excel are used as database at primary, secondary and tertiary health facilities but the HMIS tools and DHIS2 platform is more accepted
		project supervisors 10	The HMIS tools are used in around 90% of the health care facilities in the country, this includes primary health facilities, secondary and tertiary health facilities.				

			Though EMR is also used at tertiary facilities.				
		Data clerks 1	The community uses the CBIS that is under the HMIS tools, HMIS tools are used at primary health & secondary facilities and EMR is used at tertiary facilities	Data clerks 2	The HMIS tools, CBIS tools and other excel record data base are used at primary health & secondary facilities and EMR is used at tertiary facilities	Data clerks 3	The EMR and HMIS tools are used at the tertiary health facilities, HMIS tools are used at primary health & secondary facilities and the CBIS are used at the communities for recording.
		Data clerks 4	The HMIS tools, EMR, Microsoft excel, Microsoft and a few Microsoft Access database are also used at primary health, secondary and tertiary facilities				
3	What platform(s) are used for data storage and management?	Data managers, analysed responses	The DHIS2, hard drive, central backup and cloud storage	2	The DHIS2 platform storage, central backup, external hard drive and cloud storage	3	Mainly DHIS2 platform central backup is used.
		4	The DHIS2, hard drive, and cloud storage	5	The DHIS2 internal storage, central backup, external drive and cloud storage	6	The DHIS2 instance back up, hard drive, central backup and cloud storage
		7	The DHIS2, external drive, disk, central backup and cloud storage				
		Project manager	The DHIS2 platform has a central storage systems, hard drives and clouds are used too.	2	The DHIS2 platform storage system, disk, national central storage systems, hard drives and clouds.	3	The DHIS2 platform back up, external drives, strong flash drives, central storage systems, hard drives and clouds.
		4	The DHIS2 platform storage systems, drives and clouds.	5	External hard drive storage, the DHIS2 platform central storage systems, hard drives and clouds.	6	The DHIS2 platform central storage systems, hard drives and clouds storage system.
		7	The in built DHIS2 platform central storage systems, national database, hard drives and clouds storage systems at different level.	9	The national DHIS2 storage, external hard drive, and cloud storage.	9	The DHIS2 inbuilt system storage, external drives, flash drives and cloud storage

		\10	The national DHIS2 platform central storage systems, iClouds storage and external drives.				
		project supervisor's analysis	The iCloud storage, DHIS2 platform central storage systems, external hard drives and disk.	2	The DHIS2 instance central storage systems, Disk and the iClouds storage system.	3	The DHIS2 platform central storage systems, National central data storage and iClouds data storage.
		4	The DHIS2 storage system, external hard drives, hard drives, iCloud data storage system and the national central storage systems.	5	The national DHIS2 platform central storage systems, ministry of health central database, external hard drives and the iClouds data storage system.	6	The iClouds data storage system, the DHIS2 platform central storage systems and the external hard drives.
		7	The ministry of health database, the DHIS2 platform central storage systems, hard drives and iClouds storage.	8	The DHIS2 instance national central data storage systems, external hard drives, disk and iClouds data storage system.	9	The DHIS2 platform central storage systems, hard drives and national central data back up.
		10	The national DHIS2 platform central storage systems, ministry of health back up system, hard drives and iClouds back up.				
		Data clerks'	The national central data back up, DHIS2 platform central data storage systems, external hard drives back up and clouds back up.	2	The DHIS2 platform central storage systems, hard drives back ups and clouds data storage back up.	3	The DHIS2 platform central storage systems, external hard drives and disk drives.
		4	The central DHIS2 platform central data storage systems, national ministry of health database back up, hard drives and clouds data storage facility.	5	The DHIS2 platform central data storage systems, One drive, external hard drives and the iClouds data storage back up.		
4	Do you have partners supporting health data management in the health sector?	Data manager's	Yes. United States Agency for International Development	2	Yes (USAID & Measure evaluation)	3	Yes (USAID, Measure evaluation and WHO)
		4	Yes (Measure evaluation and USAID)	5	Yes (Presidential Emergency Plan for AIDS Relief - PEPFAR and WHO)	6	Yes (Measure evaluation, USAID and MEMS)
		7	Yes (Measure and PEPFAR)	8	Yes (Presidential Malaria Initiative (PMI) and PEPFAR)	9	Yes (PEPFAR)
		10	Yes (Measure)	Project manager's responses	Yes (WHO)	2	Yes (WHO and Ministry of health)

		3	Yes (MoH)	4	Yes (MOH and PEPFAR)	5	Yes (MOH and WHO)
		6	Yes (PEPFAR and Ministry of Health)	7	Yes (Ministry of health and USAID)		
		project supervisors' responses	Yes ((PEPFAR, Measure and Ministry of Health)	2	Yes (non-governmental organizations (NGO) and USAID)	3	Yes
		4	Yes (Nongovernmental organizations and PEPFAR)	5	Yes (Presidential Malaria Initiative (PMI), Measure and PEPFAR)	6	Yes (PMI, PEPFAR and ministry of health)
		7	Yes	8	Yes (PMI, ministry of health and PEPFAR)	9	Yes (Presidential Malaria Initiative (PMI) and ministry of health)
		10	Yes (Presidential Malaria Initiative (PMI) and PEPFAR)				
		Data clerk's responses	Yes (Presidential Malaria Initiative (PMI), ministry of health, WHO and PEPFAR)	2	Yes (World health organization – WHO, ministry of health and PEPFAR)	3	no sure
		4	no response	5	Yes (World health organization – WHO)		
5	What is the partner's role in data management?	Data manager's responses	Capacity building of data staff and payment of some data clerk's salaries	2	Data systems strengthening and training for key data staffs that includes some data clerks' salaries	3	Systems strengthening for data staff and payment of some data clerks' stipends
		4	Systems strengthening of the data systems	5	Training and capacity building for data staff and payment of some data clerks' stipends	6	Training of data staff and payment of some data clerks' salaries
		7	Community capacity building for data staff and health facilities.	8	Payment of some data clerks stipends and community data collectors' salaries	9	capacity building for the data systems of the county and payment of some data clerks' salaries
		10	capacity building for data staff	Project manager's responses	Public health facilities system strengthening on data and use	2	Data capturing capacity building and stipend for data clerks
		3	Capacity building for data officer and volunteers.	4	National health management information systems	5	Support to the national data flow systems

					strengthening and training		
		6	Supporting the health management information systems through capacity building	7	Capacity enhancement of healthcare facilities and healthcare personnel regarding data administration and application.	8	Training on data requirements and utilization for the national data systems
		9	Data demand and use training and capacity building for data staff and health workers.	10	capacity building for data staff and community health workers	11	Support to capacity building of data staff, and training for community health system data collection
		12	Not very certain but there is training on data collection	13	capacity building and systems strengthening for health and data staff	14	payment of some data clerks' salaries
		15	Systems strengthening for data and information use	16	no response	17	no response (not too sure)
		Data clerks	Support to data officers and volunteers' payment of some data clerks' salaries	2	Assistance to the national data request and utilization systems	3	Data necessity and use productivity training and capacity building
		4	Support to the national data bank and information use	5	Information use at the facility level training and capacity building		
			Relevance				
6	What do you think the data management team has done well? What would they have done better?	Data managers responses	The data management team have done well in entering data but can do better in the area of timeliness of entry.	2	The data management team have done well in introducing this unified system of data collection, but timeliness of data entry should be improved.	3	The data management team have done well in sensitizing the health system on unified HMIS of data collection, but timeliness and completeness of data can be improved.
		4	The data team have done well in the area data enforcing a single data entry system but can do better around capacity building	5	The data management team have done well in the health management systems enforcement and usage all around the counties and in data collection, but training of data entry staff should be improved.	6	The data management team of the MOH has effectively implemented the health management information system in health facilities, as it has established a

							cohesive reporting system; however, there is room for improvement in terms of capacity building.
		7	The data management team from the ministry of health has challenges with transcription errors from HMIS tools to DHIS2 but had done well with the coordination of information application into the DHIS2 platform.	8	The ministry of health data management team has done well in the area data organization into a single data entry system but can do better around capacity building	9	The MOH HMIS unit data team has challenges with many transcription errors from HMIS tools to the DHIS2 platform, but had done well with data entry on the DHIS2 instance
		10	The data management unit and the ministry of health data team have challenges with data quality issues and transfer errors from HMIS tools to DHIS2 at the health district level, however, the HMIS unit had done well with the coordination of data entry on DHIS2 and usage to some extent.				
		Project manager's	The ministry of health data management team could do better in enrolling more data entry staff into the System in partnership with the ministry of health; nonetheless, the team has performed admirably in the field of data organization into a unified data entry system.	2	The data management unit and the ministry of health data team should improve in extended capacity building method to further strengthen the data flow system, though with good success in a uniform data collection process, the challenges with data quality and transfer errors from HMIS tools to DHIS2 can still be reduced.	3	The health data management team of the ministry of health has done well with data collection, collation and transfer coordination but they need capacity on data verifications and quality issues especially at primary health facility levels.
		4	The data management team has done well with data entry, but they need capacity on data verifications and quality.	5	The HMIS unit and data management team has done well with data entry, but they need capacity on data on site verifications activities and data quality.	6	The team responsible for data management in the ministry of health and the health information management unit of the ministry has done well with data entry, but they need capacity on data verifications,

							supervision and data quality
		7	The HMIS unit, donor strategic information unit and ministry of health data management team have done well with data demand, coordination and flow, though they still need some form of capacity at the health district and facility level. .	project supervisor s' response	The data management team of MOH and the strategic information team of the USAID have done well with data collection and flow in the country, but they need to increase the training and capacity building for staffs.	2	Capacity building for staff and data quality has been where we hope can always get better, however the data management team that includes the HMIS unit and donors have done well with data collection and use in the country.
		3	Data use has been a huge gap that could be better in the malaria interventions of the country, even though the data management team of the ministry of health and donor agencies have done well with data coordination. In addition, capacity on data verifications and quality exercises is still very important.	4	The data management team of MOH and the supporting donor agencies have done well to improve a very steady data collection system in Liberia, also with the quality of data entry but they need capacity on data verifications and quality exercises at the facility levels.	5	The coordination has been really improved by the data management units of the ministry and donor agencies as a team, however, with data entry supervision and capacity on data verifications and quality. Some improvements are needed.
		6	Date use in one key aspect that the data management team and the ministry could do better, Though the data management team has done well with data coordination and supervision to an extent.	7	Data use is still an aspect that the data management team should do better in, the HMIS unit and data management team have done well in the organization of data flow from communities to national level, but the data has to be used.	8	For me its data use, even though completeness of data poses its own challenge, but the gathered data can be used. However, the data management team of the country team have done well in coordination and data entry but can do better in the area of timeliness in entry.
		9	The MOH data team and HMIS unit of the ministry have done well in data aggregations, entry, collation and transfer of data coordination but the area of timeliness of entry can be better.	10	Timeliness and completeness of data still affect data quality and needs to be improved, the data team however have done well in the coordination of data demand and use but		

					again can do better in the area of data quality		
		Data clerk's responses	The data management team need to improve on capacity building for data entry health workers and staff, the data management od HMIS unit have done well in the data coordination and tools availability but can be increased.	2	Tools availability is one very good improvement by the data management team and unit, but equipment is a very big challenge, especially internet and computers. Though have done well in entering of data and coordination.	3	Data entry equipment such as computer, electricity and internet has been a significant challenge at the district's primary health care level. However, the data management team of the ministry and the HMIS team have done well in data coordination and tools supply.
		4	The data management team and other supporting organizations have helped stabilize the data collection systems, but the challenges still remain timeliness from primary health facilities due to delay or no internet connectivity. The team have done well in the supply of tools for data capture but can do better in this timeliness of data entry and reporting.	5	The data quality from health facilities have been hampered with connectivity interruptions and delay of reports from hard-to-reach areas all due to internet and computer systems issues. Though, the data team and HMIS unit have done well in data entry and availability.		
			Efficiency				
8	How would you rate data performance and demand so far?	Data managers	Data collection has been good, but we collect because funders ask us to collect		The challenge in rating data performance is in the fact that data is used mainly for donor support planning, this is why data demand is also climbing.		Data demand has improved because its clear with the way data collection has been improving.
			Data demand by the donors have improved data collection at the facility levels, this has been a good improvement.		Data demand and use have been a focus for some years now and has pushed up the data collection drive and the health facility performance		Data demand and performance have increased and measured by its uses, planning for interventions and quality of reporting has improved to an extent.
			Data quality performance even though not there yet has improved program planning; this has also led to data		Data performance and demand have increased data collection and		Data collection for program planning has been good, but we

			demand in Liberia. So, it has been a good performance rate.		reporting rate for program planning.		collect because funders ask us to collect.
			Data demand is still far; we call for data only when we are asked. The country needs to understand performance				
		Project managers'	Data demand is still at a lower rate; data mangers call for data only when they are asked by donors. The country needs to understand what data performance means in interpreting data.		Data demand is still at an improving rate; we call for data only when we are asked. The country needs to understand performance		Data demand is still a little below the expected performance, data is expected to advice the malaria implementation, but we call for data only when the data is needed.
			Data performance in the malaria intervention has increased data demand, but data use is still expected to get better in the performance.		Data use is still far from expected as a result of lack of feedback, though data is collected at facilities but might not be due to data demand.		Data is often collected at the facilities and donor demand for data is on the increase due for implementation, however we call for data only when we are asked.
		project supervisors'	Performance of data is still a little below the expected rate as some implementations are not driven by data, data is called for only when we are asked by the ministry for planning.		Data demand is still on the increased, the ministry of health now demands for data for future planning. Though quality of data is still a little set back.		we collect because funders ask us to collect data for reporting, the national planning unit of the MOH ask for data now.
			The health facilities collect data because funders ask us to collect		The health care facilities we collect data because ministry of health ask for the collection and reports.		The health district facilities collect data and report to the DHIS2 but no feed backs to understand the performance.
			Data performance is not easy to be measured at the health district level because there are no feed backs from the top on data use		Performance of data at the health district and facilities level might not be measured because we do limit data analysis at this level.		We try our best to do some analysis but not there yet, performance and demand is mostly by donors and not government.
			Performance and demand are mostly by donors and the ministry, we only collect data but not involved in planning.		The data experts just try their best to do some little analysis but on smaller scale, performance and demand is mostly by donors and the government		

		Data clerks'	Analysis is not usually done at this level but performance and data demand is mostly when donors ask us donors and not government		The feed back system is very bad and so we just collect data		No feedback and so not too surf
9	What has been accomplished with data in the nation, or how would you characterize the use of data for decision-making in health systems?	Data managers	The country relies on donors and funders, so data is mostly used by funders and donors to plan implementations		Data for planning is mostly by supporting organization on interventions.		The country data is mostly controlled by the funding agencies due to the planning, and so decision making relies on donors and funders, so data is mostly used by funders.
			Data use in the country in just in its improvement stage, the ministry of health has improved on data through the HMIS platform and data can be pulled out for planning.		Data use and decision making in the health system especially malaria has seen some form of improvement through its collaboration with funding agencies.		The country relies on donors and funders lead on health data and decision making, this is due to the funding mechanism being dependent on.
			Data use in the country as regards planning for interventions is still on a slow pace		The ministry of health data use in decision making is not where it should be in the country yet.		The HMIS system has supported gathering and analysis at the central level data use in the country is still very low
			Health data utilization in the nation occurs through the Ministry of Health's health management information system; however, it has only been employed for program planning when funding is available at this time.				
		Project managers'	Data use in the country is still advancing especially in planning national documents for the health systems.		Data use in the country is used in collaboration with donors to strengthen health systems		Data use in the country is still very low
			The MOH in the country uses health facility data when applying for funds or planning national documents		The country uses aggregated data from the HMIS platform and other sources mainly when applying for funds		The MOH uses data mostly when carrying out fund applications
			The ministry of health and donor agencies uses health data for funds application and developing national documents				

		project supervisor's	National health data by the ministry of health do not guide decision on policy formation but used mostly when applying for funds more		The national health data of the MOH guides decision making on some health policy formation and used for applying for funds more		The Liberia national health data from the ministry of health guide decision making on policy formation and planning but used mostly when applying for funds more
			National data from the health ministry and donor agencies supports decision making on policy formation and planning in the country but sectional. Not all the counties' data are used sometimes.		The country's district health data do not support decision making at the health district level as supposed, however a central decision making from data is engaged for planning.		Data use in the country is still very low as compared to the expected health planning from data led decision making
			Data-driven decision-making and its application for planning and policies in the nation is still in its developing stage.		Data use in the country is particularly periodic, and this is the stage of proposal writing or fund applications.		Data usage for decision-making, assisted by the funding partners within the country, is consistently increasing.
			The country data is sometimes used for planning when applying for funding or writing proposals for funding				
		Data clerks'	The donor agencies in conjunctions with the ministry of health use the data for planning and when writing applications for funding		The country information is utilized for making decisions during the planning phase and when composing requests for funding.		The health ministry most times use the data for planning when writing and applying for funding
			The country sometimes use data for planning when seeking, applying or writing for funding		The ministry of health sometimes uses data for planning when writing for funding		
10	What do you think can be done better?	Data managers'	The country needs to own the data and not depend on donor for analysis		The country must analyse for its own performance and know how to improve interventions		The government needs to enhance the frameworks for analyzing information from the district up to the national level.
			The health ministry needs to enhance the systems to analyze data from the district to the national level.		The health information management systems unit must analyse for its own performance and know how to improve interventions		The data unit of the ministry of health must analyse for its own performance and know how to

							improve interventions
			The country needs to own the data from the health districts facility and not depend on donor for data collection and analysis.		The country through the HMIS unit and other units must analyse for its own performance and know how to improve interventions		The national data unit of the MOH should own the data from the health districts facility and not rely on donor for data gathering and examination.
			The MOH needs to enhance the data systems to assess and interpret district data up till national level, this will enable the country to own the data and not depend on donor for analysis		The MOH through the HMIS unit must strengthen the data systems to analyze interpret data from district to national level, this will enable the country to own the data and not depend on donor for analysis		The country health ministry and the HMIS unit have to own the data, analyse and interpret for good decision making. not depend on donor for analysis
		Project managers'	For the country not to depend on donor for analysis and interpretation for decision making, the ministry of health should build staff capacities for lower and higher-level interpretations.		The government must strengthen the systems to interpret data from district to national level for good decision making and planning.		The donor agencies with the health management information unit of the ministry should support the government to strengthen the systems to interpret national level data obtained from the district facilities
			The health ministry must strengthen the data systems to analyze interpret data from district to national level; this will enable the country to own the data and not depend on donor for analysis		The donor agencies should support the government and ministry strengthen the systems to interpret data from district to national level		The government should establish a continuous strategy to strengthen the systems to be able to use facility data that flows from district HFs to regional and national level
			The government and health ministry in collaboration with donor agencies should strengthen the systems to interpret data from district to national level for proper planning.				
		project supervisors'	Data collection should become a holistic affair that involves both the health workers and data staff, Also, the government must		Key health personnel from healthcare institutions should participate in data collection and		The government ought to motivate additional health workers in gathering data and

			strengthen the systems for all levels to interpret data		analysis at various levels to support decision-making within the health system.		enhance the systems to comprehend the data for application at every level up to the national level.
			Health facility levels from the primary health care to health district and counties are very important in planning, and so the government must strengthen the systems to interpret data from district to national level		The health management information unit of the MOH should cover more ground in its systems strengthening to involve other health workers, this will make data completeness and validity very viable.		The government must take systems strengthening and capacity building as a huge segment in data requirement and application, this will allow the systems to understand data from local to national level
			Health workers and data clerks are at the heart of data management in the health ministry; government must strengthen these data staffs at all levels to interpret data		The healthcare professionals at the grassroots and primary health tiers, who serve as the primary field operators, need to be reinforced so that the systems can gather quality data at every level, encompassing both regional and national.		Health workers and health data staffs should be strengthened for the systems to collate and transfer complete quality and timely data reaching to national level
			For the country to analyse data of its own and increase performance and know how to improve interventions, a lot of training is needed.				
		Data clerks'	Holistic capacity building on data demand and use that includes analysis in deeded for the national data performance and improved interventions		The health ministry and other supporting organization should build capacity of health workers on key analyses for its own performance and know how to improve interventions		To improve data quality, performance and achieve adequate analysis to know how to improve interventions in the nation's healthcare system. The health ministry ought to concentrate on capability of the staff.
			The country through the MOH should pay special attention to analyses for its own performance and know how to improve interventions		The ministry of health and HMIS units should prioritize trainings on data quality and analyses for its own performance and		

					know how to improve interventions		
			Effectiveness				
11	Would you say the objectives of data management for decision-making has been achieved and on time?	Data managers'	Not yet, like 55%		No, I wouldn't for now, like 55%		No, maybe like 50%
			No, I can say like 47%		No, like maybe 50%		No, but like 50%
			No, for me its like 50%		No, it's like 50%		No, like 45%
			No, just above average 60%				
		Project managers'	No not exact, say 55%		No, like 60% or so		No, will say 50% or just a little above
			No, a little above 55%		like 50%		Will say like 50%
			Can't really measure but say 65%		No, 50% of its achievement		No, like 40% or less
		project supervisor's	No not yet but improving to like 45%		Improving but not there yet, like 45%		No, but improving
			Not yet but improving		Will assume less than 50%		No not yet but getting better
			No not yet, perhaps in a year.		No, but can't say exactly for now		
		Data clerks'	No, not yet there		No, not yet		no response
			No not yet but improving		No not yet but at a rate of 55%		
12	Were there some challenges or successes that influenced the achievement or non-achievement of the HIS?	Data managers'	The challenge is funding to keep the data clerks, most of them are funded by donors. This is why achievement is a bit difficult to measure		So far, there is a form of success, but government need to retain staff and data clerks to improve decision from data.		The health information system is hampered by too much door reliance
			The difficulty with the health system information lies in the financing to maintain the data clerks, the majority of whom are financed by donors. This		The achievements reached through data by the ministry of health is the primary and consolidated data systems, but the		The challenges to keep data clerks has been a major set back on the country's data demand

			is why achievement has not been gained.		challenges are the funding to keep the data clerks, most of the data clerks are on data donor support.		achievement, the donors have a very important role in salaries and stipends payments. This is why completeness of data has not been achieved as expected
			Keeping data staff has been a huge challenge but the health system HMIS and the reporting systems has been a good achievement.		Funding to keep the data clerks is of a huge challenge with the ministry of health, most of the data clerks are funded by donors. This kind of donor dependant affects data systems when donor leaves.		The ministry of health has successfully established an HMIS unit that coordinates the data systems of the country and has achieved one data reporting system
			The primary accomplishment with the health management information system is financing to retain the data clerks, as most of them are supported by donors funding. This is why data collection and flow has been achieved to this level.		The country has achieved a huge stride in a unified data systems using the HMIS uniform tools.		The national health management tools and the DHIS2 platform has improved the expertise of data clerks and health workers at the community.
		Project managers'	Keeping the data clerks could be a challenge, but this has also engaged the health information system to achieve an increased data collection rate and data base.		The health information system is hampered by too much door reliance, but this has also been a success and assisted the ministry of health in enhancing the health information system		The HIS is hampered by issues around data quality too but there has been a good improvement in the system however, too much door reliance is still a challenge.
			The Liberia health management information system achievement is being noticed through the improved and unified HMIS tools and DHIS2 data systems.		The Liberia health system has undergone some key modifications that enhanced the data gathering and evaluation system for important decisions.		The information collection and analysis system for key decisions has increased in recent years, this is due to HMIS unified data collection and reporting system.
			Data demand and use in the country has been improved and also improved the decision-making abilities from data.				

		project supervisors'	Up to this point, there exists a degree of achievement in health information systems; however, the government must keep staff and data clerks to enhance decision-making based on data.		There are a significant improvement and success in the health information systems, however the government must seek a solution to retaining staff and data clerks at the health facilities.		For decision making from data to improve, the health ministry must find a way to retaining staff and data clerks at the health facilities. As this will further strengthen data flow and data quality for data use.
			The ministry of health needs to own the staff and staffing processes that includes data clerks to enhance decision making from data.		The health district and counties must undertake certain responsibilities to owning data clerks and other data entry staffs, this will improve the health information decision making from data.		Health information systems success is tied around the use of data and retention of data staffs; this has been noticed in the ministry of health that improves decision from data.
		project supervisors'	So far, the health information system has gained some form of success, but the government need to retain staff and data clerks to improve decision making right from the health facilities level.		No not yet but improving through the HMIS systems and data use to plan programs at national level.		The health information system has gained good achievement in the usage of the HMIS tools to gather data in uniformity, but it is hampered by too much door reliance.
			The health information system data usage has been commendable in its uniformity in data collections and transfer for analysis and use at the central level				
		Data clerks'	The HIS has improved the data quality planning and supervision at health district facilities level, this will support good decision making from data.		The over reliance on donor funding for health information systems is still a challenge for the health ministry, but this process has increased data demand in the country.		The health information system of the ministry of health relies so much on donor support but the ministry of health now has a coordinating unit which is a success.
			The MOH in strengthening the health information system, now have an HMIS unit that coordinates the health information systems as a		The health information system data quality has improved through health facility supervision; this is a		

			success, but its still hampered by too much donor reliance		good development that has increased data demand and use.		
			Sustainability				
13	How has the HIS improved the technical skills/capacity of the health system?	Data managers'	The health information systems have increased the health systems knowledge and capacity in developing policies and key documents		The health system has different reporting system for different disease such as the EMR, so it has improved the systems through different trainings and capacity building in other to strengthen the health systems and management		The health information systems in recent years have included capacity building as a key function to strengthening the systems, this has in turn improved the capacity of health systems workers through the reporting systems
			The HMIS tools and DHIS2 serve as the primary data platform for collecting malaria data and have enhanced the technical expertise of the data management team through a consolidated reporting system.		The Liberia health system has one reporting system but different platforms for different disease such as the EMR DHIS2 is the only platform for malaria data and has improved technical abilities for data management through unified reporting system		The DHIS2 and the EMR is the recognized platform for malaria data that has improved technical skills of the health workers and data staff for data management through the unified reporting system
			The health management inform systems and tools is the major platform for malaria data and has improved technical knowledge for data management staffs and health workers through mentoring on the reporting system		The national health information system, which comprises the HMIS and DHIS2 platforms, has enhanced technical expertise for data management through training and capacity building in data capture and reporting. Technical skill for data management staff and field staff have improved		The health information system and its management through the HMIS unit have put a lot of efforts strengthening staff being the only platform for malaria data and reporting through the DHIS2 platform
			The DHIS2 and HMIS serve as the exclusive platforms utilized by the ministry of health for malaria data in malaria interventions, has improved technical capacities for data management through unified reporting system		The HMIS tools through the training and usage have strengthen data, has creased knowledge for data staff and health workers.		The one reporting system approach and data use from one source has improved the health information systems and its management in the country

		Project managers'	One reporting system implemented by the ministry of health has enhanced the health information systems.		The one reporting system has made the difference for the HIS in the country.		One reporting system has brought the health workers and data expert to build capacities and strengthen the health data systems.
			The single reporting system strategy utilizing the DHIS2 platform has transformed the data flow and application in the health information system by using a singular source; the management of health information systems in the country is now overseen by skilled personnel.		The unified and one reporting system on the DHIS2 gave opportunity for systems strengthening.		One reporting system has build the capacity through one understanding of data flow.
			One reporting system implemented by the national health system transformed the landscape of data in the country.				
		project supervisors'	The health system management has enhanced the technical skills of the health system in the country by involving key health workers and data staff.		The strategies and reporting of the national health information system have enhanced the technical capabilities of the health system through essential training.		The HIS through engaging the community health workers in data gathering, has boosted the technical capacity of the health system from down to the top.
			Data capture platforms such as the EMR and the HMIS2 are used in the country health facilities for malaria, so it has improved the systems through different trainings.		The health information reporting system for different disease on organized electronic database platforms such as the EMR and the HMIS2, has improved the systems through engaging staff all over the country.		
			Using the EMR at the tertiary facilities and the HMIS2 at the primary and secondary facilities, has improved the systems through different trainings for the data officers and it builds the systems		The health information system coordinated by the HMIS unit of MOH, uses data base for disease such as the EMR and the HMIS2, so it has improved the systems through different trainings.		The HMIS and district health information system has brought together the key diseases and made planning easier in the health systems.
			The health system has made planning and information use easier by collecting data from one major platform. such as		. The DHIS2 instance is the only platform for malaria data and has improved		

			the EMR and the health information management systems (HMIS2.		technical skill for data management through unified reporting system		
		Data clerks'	The participation of all healthcare personnel and data staff in the health information systems and data flow has enhanced the capability of health systems and strengthened the health system.		Understanding the HIS by the data entry staffs at the facilities has contributed to strengthening the HIS and management.		The data clerks and some health workers are now called upon for some planning and policies development exercise using data, it has made the HIS improved the capacity of health systems through this form of knowledge
			The HIS certainly improved the data quality of health systems via this consolidated reporting system and training sessions.		The improved data collection and flow systems are attributed to the health information systems growth achieved through this unified data system		
14	What were the significant factors that influenced the achievement or non-achievement of sustainability of the HIS?	Data managers'	The development and capacity enhancement for personnel supports the sustainability of the health systems.		The establishment of the HMIS unit for coordination and organization has influenced the sustainability achievements of national health systems and its information gathering thus far.		The development and skill enhancement for personnel contributes to the sustainability of the health systems, this is a significant factor that influenced the achievement.
			One of the major elements that will impact the sustainability of the health information system is the training and capacity building for staff that helps the continuous planning of the health system disease intervention.		The key element in the health system is enhancing the capabilities of the staff; this will support and sustain the data system and planning in health systems		The health system planning and policy development with relevant and quality data is a key achievement from the health information system, this can be sustained through education and skill development for personnel in the health systems.
			Capacity building and mentoring for staff helps increase data knowledge and the sustainability of the health		In sustaining of the HMIS, the health ministry had its focus on training and capacity building for		A significant element that has been utilized by the ministry of health is the

			information systems in the country		staff and health workers		HMIS coordination division of the ministry and training and capacity development for personnel to maintain the health information systems.
			A crucial element that helped in meeting the heightened demand for data and its application in planning to support the sustainability of the health information system is the cross-training and engagement of health workers and data officers.				
		Project managers'	Sustainability of the health information system can only get stronger or better if the ministry of health can stand on its own, so one factor affecting the sustainability is lack of ownership for now.		Fund raising and ownership of data and the data systems, capacity building for staff helps to build the sustainability of health information systems		Staff development (health workers and data entry officers) helps the sustainability of the health information systems
			In addition to training and capacity development for personnel that supports the sustainability of health information systems, taking ownership of the processes within the system, which encompasses staff salaries and stipends for volunteers, will enhance value.		The staff salaries and stipends will prevent staff attritions and expertise will be retained to improve sustainability.		A decrease in staff turnover by having the ministry of health take responsibility for all data staff will support the health information system.
			Salaries and stipends for some data staff are being handled by some donor agencies, this will not support the sustainability plan for the health inform systems.				
		project supervisors'	Donor agencies support funding to data clerks at the facilities		Support funding to data clerks at the facilities will keep staffs and sustain the health information system		Capacity support and funding to data clerks at the facilities
			Support to health workers and data staffs such as salaries and stipends to data clerks at the facilities		Ownership of the community health workers and data clerks at the facilities is a factor that will strengthen the system.		Non ownership and support funding to data clerks at the facilities by the ministry of health affects sustainability

			Not too sure but capacity build and training for data staffs will sustain the health information system data processes		The supports to data clerks and health workers at the facilities in terms of stipends by the ministry of health		Some very important factors that limits the health information systems achievement and sustainability, is the health ministry non ownership of data clerks at the facilities
			Not ownership of most of the data clerks at the health facilities is a challenge to achieving health information system sustainability.				
		Data clerks'	Most of the clerks are not supported by the MOH or being paid by the government, so it drags sustainability back.		no response		no response too
			Low or minimal recruitment of technical staff for data entry at the facility is a set back for sustainability		An intentional recruitment of technical staff by the government will improve the sustainability process of health information systems in the country.		

This key informant interviewer's analysis from stakeholders, staff and Project Management

This team responses comprised of 128 respondents that were carefully captured and transcribed for representation in this study due to the essence of its country's importance.

These respondents' categories comprise of 48 data managers, 32 project managers, 15 project supervisors and 25 data clerks.

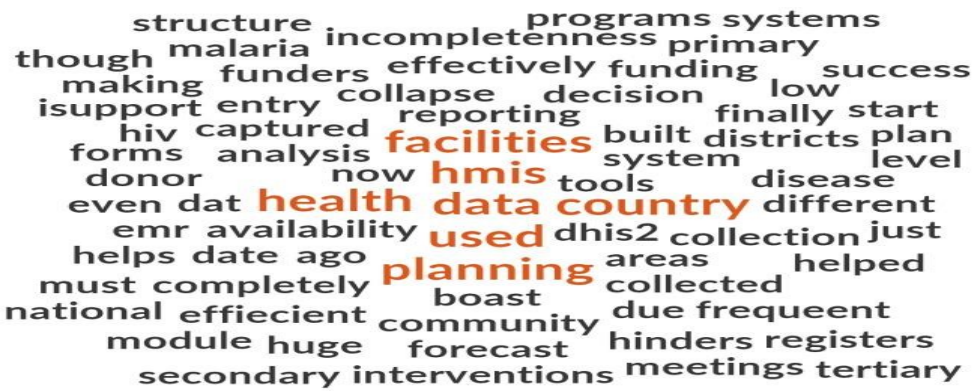
Interviews and FGDs

- *Briefly describe the health system data collection process.*
- *What data collection tools are used in the data collection process at every level of facilities?*
- *What platform(s) are used for data storage and management?*
- *Do you have partners supporting health data management in the health sector?*

- *What is the partner's role in data management?*

Cloud 4

Presentation Word Counts



"There was a unanimous response that the health system uses the HMIS tools to collect data and report on the DHIS2 platform, which serves both visualization and storage purposes for the country's malaria data".

"*The participants acknowledged the partnerships and support from donor partners to enhance the institutional and human capacity in using HMIS tools and payment of salaries*".

This interprets that the malaria program of the health systems uses the uniform HMIS called the Districts Health Information Systems 2 DHIS2 platform to collect data. As a storage system, the storage system also includes disk and cloud storage. The study also found that data collection tools (HMIS tools) are used in the data collection at every level of facilities (both primary, secondary, and tertiary) even though the secondary and tertiary use some other Electronic Medical Records different from the national HMIS.

RQ: How reliable and appropriate is the malaria HMIS data for malaria control decision making?

Hypothesis1

Ho: The developed health management information system is not reliable and appropriate for malaria control decision-making

Ha: The developed health management information system is reliable and appropriate for malaria control decision-making

Reliability and appropriateness were measured through the data and HMIS/DHIS2 efficiency questions.

Efficiency

- *How would you rate data performance and demand so far?*
- *What has been done with data in the country, or how will you describe data use for health systems decision-making?*
- *What do you think can be done better?*

"The data managers are particularly explanatory that the data has helped get a clear picture of malaria incidence in the different counties and what interventions have been working in their response".

"*However, the project managers and supervisors would like reduced transcription errors during data entry and timely data entry for quick decision making"*.

One of the data managers said, "*the data team have done well in entering data but can do better in the area of timeliness of entry*".

On the challenge of transcription errors from HMIS tools to the DHIS2 platform, a data manager said, "*The data team has challenges with transcription errors from HMIS tools to DHIS2 but had done well with data entry on DHIS*".

This feedback underscores the areas that need improvement while acknowledging the HMIS system's positive impact in strengthening the country's malaria program.

Cloud 5

Word Frequency for Data Performance Rating by Participants

This interprets reliability and conformity to the national HMIS standard, and procedures being followed across the country as pointed out in the literature. However, there are challenges as indicated in the word count frequency as demonstrated by the cloud presentation 2 above.

a) In the description of data performance and demand: it was clear from the study that transcription errors are a huge challenge in the country even though the malaria cases are being entered using the national HMIS system, this means wrong analysis and predictions could be derived from such data and could mislead planning processes and decision making in the country’s malaria health system.

b) For data utilization in the country or data application for health systems and decisions that are made: the study participants indicate that this is

applied solely when the funders or donors require it and not for national planning purposes, meaning only when funding proposal is being demanded. This will not tell the disease epidemic or pattern in the country because it will be sectional according to the funder or donor intervention.

c) Timely data entry was a huge concern during the study from respondents; this will hinder prompt interventions or epidemic trends due to delay in data entry.

Here the null hypothesis **Ho:** The developed health management information system is not reliable and appropriate for malaria control decision-making is rejected, and the alternative idea **Ha:** The developed health management information system is reliable and appropriate for malaria control decision-making is accepted. However, some improvements are needed from the challenges of timely data, data demand and use as indicated above must be overcome.

RQ: How has using HMIS data supported malaria prevention and control planning?

Hypothesis 2

Ho: The health management information system has not been pictured and used correctly.

Ha: The health management information system has been pictured and used correctly.

Using the HMIS data and the support to malaria prevention was measured through the effectiveness questions

Effectiveness

- *Would you say the data management objectives for decision-making have been achieved and on time?*
- *Were there some challenges or successes that influenced the achievement or non-achievement of the health system HMIS?*

The FGD response noted, "*there is still a long way to go in achieving the objectives of using data for decision making*".

"*Most of the data managers mentioned that there has been a remarkable achievement, but the objective has only been achieved at an estimated 50%*".

"*The sentiments of the project managers and supervisors are somewhat negative, especially around the weak capacity of the data officers (clerks) and the difficulty in paying their salaries*".

"*They believe these are key factors slowing down the growth rate in providing quality and timely data through the HMIS*".

"There seems to be a limited perspective regarding the significance of data and its application, majority of the respondents across the classifications highlighted that the main use of data is to help the country develop a proposal for funding from donor partners".

The country may need to show more commitment in using these data to identify success factors and gaps in the malaria intervention and adapt same for other health programs that have national priority.

Table 15

Tree Map for HMIS data use in the Health Sector

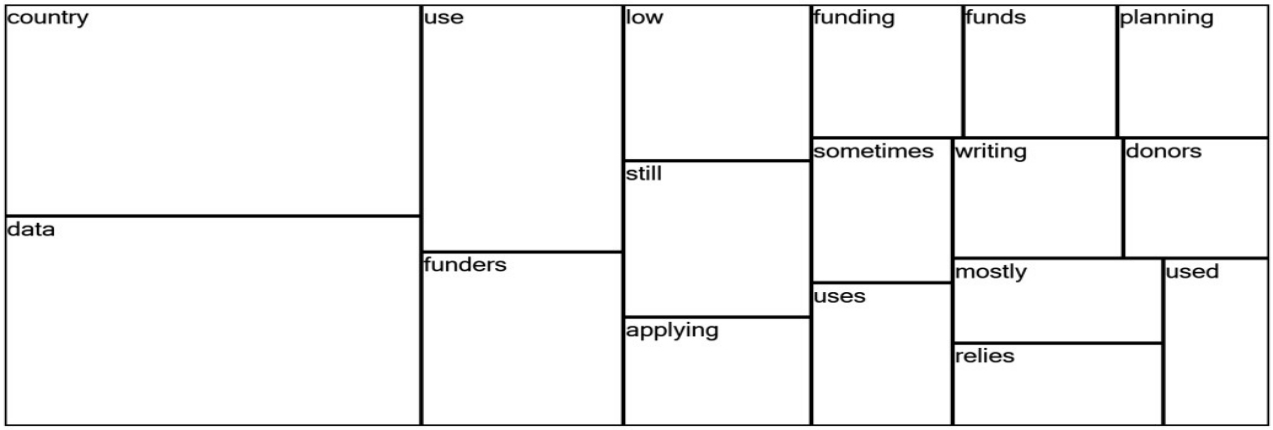
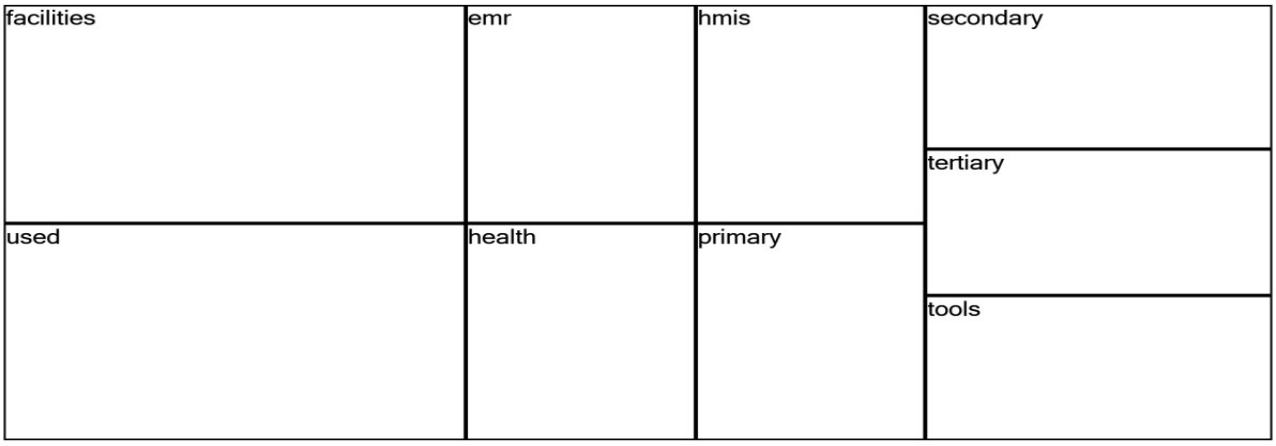


Table 16

Tree Map for HMIS Challenges in the Health Sector



Tables 2 and 3 show the data uses and challenges map from the NVIVO analysis, the key challenge is data use, which is placed at 50% and term and a major obstacle to planning

and decision making to the malaria disease. The respondents also state that weak capacity and lack of data use are key factors slowing down the growth rate in providing quality and timely data through the HMIS. This is why the null hypothesis **Ho:** The HMIS has not been pictured and used correctly is rejected, and the alternative **Ha:** The HMIS has been pictured and used correctly is accepted.

This means the HMIS is fully in existence and used, but for lack of expertise and weak staffing, it has not been pictured and used correctly for planning and decision-making.

RQ: What will determine the supporting factors for effective HMIS strengthening for malaria control in the country?

Hypothesis 3

Ho: Decisions on Malaria prevention and control have not been made using valid HMIS data

Ha: Decisions on Malaria prevention and control have been made using valid HMIS data.

The supporting factors are measured through the sustainability and Impact questions.

Sustainability.

- *How has the health information system improved the technical skills/capacity of the health system?*
- *What were the significant factors that influenced the achievement or non-achievement of sustainability of the health information system?*

"*Participants confirmed that the **one reporting system** is a significant advantage that the HMIS brings to malaria programming".*

This indicates that the country has taken ownership of the system but needs to do more to improve human capacity and have a more robust justification for using malaria data in country.

Impact

- *What real difference has the health information system made to the health system?*
- *What has happened due to the good/weak/bad health information system?*

According to the interviewees, *"the HMIS has engendered a unified reporting system idea. It has also helped the program managers and government institutions to plan malaria interventions better"*.

According to one of the project supervisors, ***"The Health information system has built way for data demand and use for planning".*** The HMIS has increased data demand and provided direction for health interventions.

Cloud 6

Word Count for The Effect of Weak or Strong Health Information Systems

Table 17

Tree Map of How HMIS has made a difference in the Health Sector

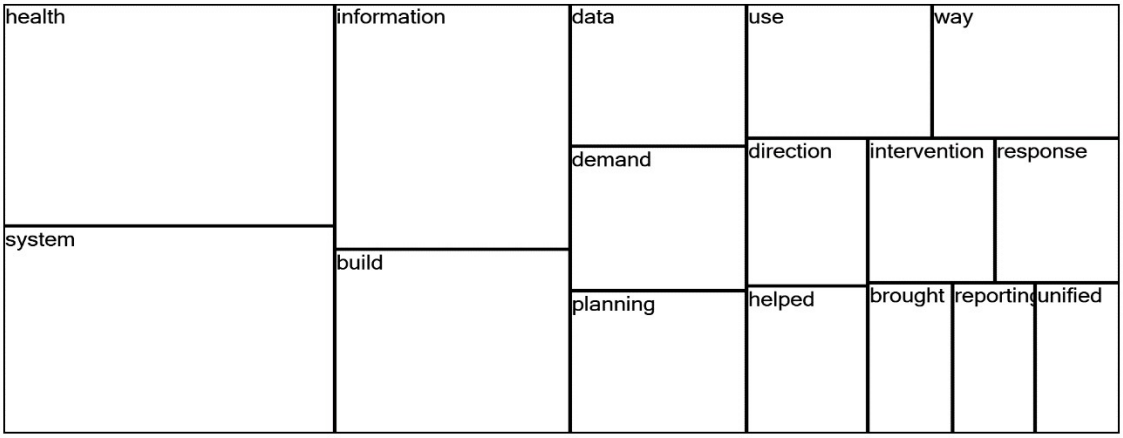
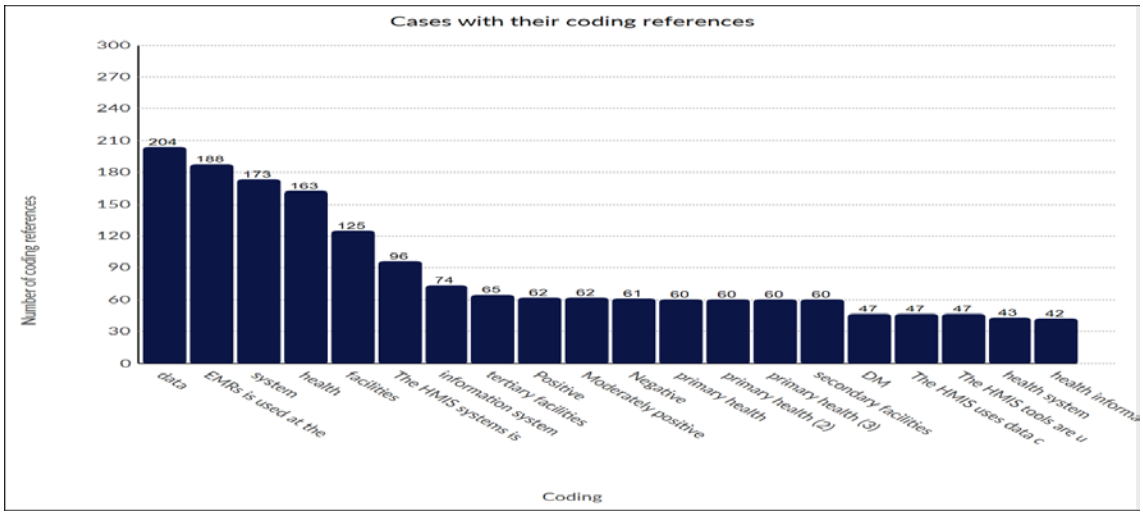


Figure 12

References for codes across different cases and classifications



This table shows the most referenced words and the sentiments expressed by the participants during the key informant interviews and focus group discussions.

Cloud 7

Word Count for Recommendations

Cloud presentations 3 and 4 show the word count for unified information system and better planning with capacity challenges, while cloud presentation 4 shows recommendation word counts in assuring proper planning and effective data usage.

This interprets that the HMIS has increased data demand and provided direction for health interventions. However, systems strengthening, and capacity building are needed to further understand data use and planning for decision-making.

Summary

Research design, results, and analysis: This study adopted a systematic research approach and philosophical outlines in the data gathering plan to engage the malaria HIS of the Liberia MOH to produce reliable reports and recommendations. In its design, the study employed a non-experimental and mixed research approach due to the strength of clarifying nature and intentions of the research (Bryman, 2006).

Quantitative and qualitative data were engaged, using both the SPSS analysis package and NIVO for the analysis.

Quantitative data. The primary data is derived from the national HMIS database for malaria and analyzed with the SPSS package.

And the qualitative data; the primary data is derived through key informant interview, observations and focused group discussion. This also helped the study to triangulate information through influential data culture of best practice.

Data gathering: Quantitative data was obtained from the outpatient and laboratory registers at the 45-health facility of the 93 business districts, including the DHIS2 database and using structured checklists and rating scales known as Likert scales to rate data availability (Leedy and Ormrod, 2005). This data collected was for a period of 5 years, and 2013-14 pre-Ebola was used as a baseline, it identified policy-relevant data such as the burden of malaria, diagnostic procedures, and treatment practices.

The key analysis and study reports focused on key aspects of data trustworthiness while the research results were based on key questions and the hypothesis. That includes:

Hypothesis1

Ho: The developed health management information system is not appropriate for malaria control decision-making

Ha: The developed health management information system is appropriate for malaria control decision-making

Hypothesis 2

Ho: The health management information system has not been pictured and used correctly.

Ha: The health management information system has been pictured and used correctly.

Hypothesis 3

Ho: Decisions on Malaria prevention and control has not been made using valid HMIS data

Ha: Decisions on Malaria prevention and control have been made using valid HMIS data.

The result interprets that the malaria program of the health systems uses the uniform HMIS called the Districts Health Information Systems 2 DHIS2 platform to collect data. As a storage system, the storage system also includes disk and cloud storage. The study also found that data collection tools (HMIS tools) are used in data collection at every level of facilities (both primary, secondary and tertiary) even though the secondary and tertiary uses some other Electronic Medical Records different from the national HMIS.

Further in the description of data performance and demand; it was clear from the study that transcription errors are a huge challenge in the country even though the malaria cases are being entered using the national HMIS system, this means wrong analysis and predictions could be derived from such data and could mislead planning processes and decision making in the country malaria health system.

For data use in the country or data use for health systems decision-making: the study respondents show that this is used only when the funders or donors demand it and not for national planning purposes, meaning only when funding proposal is being demanded. This will not tell the disease epidemic or pattern in the country because it will be sectional according to the funder or donor intervention.

Timely data entry was a huge concern during the study from respondents; this will hinder prompt interventions or epidemic trends due to delay in data entry.

From this response below,

> *"There appears to be a narrow view to the importance of data and its use, majority of the respondents across the classifications highlighted that the main use of data is to help the country develop a proposal for funding from donor partners"*.

The country may need to show more commitment in using these data to identify success factors and gaps in the intervention of malaria and adapt the same for other health programs that have national priority.

CHAPTER 5: IMPLICATIONS, RECOMMENDATIONS, AND CONCLUSIONS

Introduction

(WHO, 2022), in looking through data gaps in Africa has described HIS and its management in Africa as very challenging; this has made decision-making and planning in the health sector very difficult in programming especially in combating diseases like the Malaria burden.

In Liberia, reliable and data-based evidence decision is critical in health sector and its systems, especially in malaria interventions and control (LDHS, 2019). In other that these challenges may be addressed and to combat subsequent health challenges, two steps were identified; the first is to develop and strengthen the HMIS at the country level to provide high-quality data through health facilities as significant sources of data collection. Then strengthening the national capacity of staff and structure to collect, analyze, interpret, and utilize the data to make choices in the nation's health setting.

The obvious consequence of this data challenge is the limited availability of high-quality in-country data that limits the provision of contextually relevant decisions that will contribute to planning and improving the health system.

This research result will be presented to decision-makers to explore or recommend how evidence is perceived and used to a) further strengthen the health information system and b) inform decisions about malaria control that will reduce mortality and improve population health

stability.

As a result, this study still tends to understand the development and functionality of the HIS and its role in decision-making related to planning in Liberia health sector, especially in malaria interventions and control in Liberia.

The (LDHS, 2019) reported that malaria related morbidity and mortality declined for three years consecutively (pre-Ebola). Even though this was an excellent development, data collection and quality were problematic because of processes and systemic errors. It is now apparent that decision-making information from quality data that impacts healthcare and disease control must be in place. However, this will depend mainly on Liberia's effective health management information systems (LIP, 2009).

Methodological Approach

A case study design with a structured tool design employing a mixed-method approach was utilized in this research to involve the participants during the data collection; this has assisted the research in triangulating information through influential data culture of best practice. Data was collected at primary, regional, and tertiary health facilities, including from staff at the Ministry of Health using document review, survey, in-depth interviews of key informants, direct participation and direct observation of practices. Qualitative and quantitative data were collected to answer research questions: "How does the health management information system developed and has evolved in the past five years? "and "How reliable and appropriate the malaria HMIS data for malaria control decision-making has been?" "What determines the supporting factors to effective HMIS strengthening for malaria control in the country?" and "How has the use of HMIS data supported planning in malaria prevention and control?" While both quantitative and qualitative data were used to answer the research question, "How reliable and appropriate the HMIS data for malaria control decision-making has been?"

The proposed study data process is divided into two components, which has helped to generalize the outcome. In the initial component, the caliber of data produced by the crucial sentinel health facilities was examined, and superior quality policy-relevant data were identified continuously. In the second component, these data will be presented to decision-makers and used to explore how evidence is perceived and used to (a) further strengthen the health information system and (b) inform decisions about malaria control continuously over three years.

Summary

In agreement with the United Nations claims that in most developing countries, including Liberia, social and economic development is being hindered due to a lack of information and information systems but most especially with health systems for decision-making and planning (UN-MDG, 2000; 2015). This research is conducted based on the challenges that have been recognized, making it essential to establish a framework or methodology to direct how data might be handled for planning aimed at enhancing services within the healthcare facilities of Liberia as a vital objective (UN-MDG, 2000; 2015).

This chapter has concluded from the analysis and results on the HMIS processes and challenges in the Liberia health systems, which focus on malaria interventions data gathering and application for decision making. The outcomes have indicated that the Liberia health systems between the focus year (2013 Ebola year to 2018 and till date) use a health management information system to collect and store malaria national data throughout the government health facilities in the 15 counties of the country. However, the challenge is in utilizing the information for planning and decision-making, and gathering data from private health facilities has noted some transcription mistakes.

Ethical considerations

Approval for ethical clearance to carry out this research was requested and received from the UREC, and certified approvals were obtained.

Approval was requested and granted from the authorities of the Ministry of Health and all healthcare institutions involved:

Primary Health Care facilities, secondary facilities, tertiary facilities and ministry staff responses were numbered and coded to ensure confidentiality is preserved.

Informed consent was secured from each facility of participants prior to carrying out interviews.

The confidentiality and privacy of the participants were honored throughout the interviews.

In order to maintain the confidentiality of the participants, serial numbers were utilized instead of names to identify the respondents. To uphold privacy, interviews took place in private locations within or near the health facilities to enable the respondent to discuss any matter openly.

Participants were informed that they had the choice to decline participation or leave the study whenever they wished.

Participants were made aware that there would be no repercussions or loss of advantages for declining to take part in the study or for withdrawing from it.

All information was stored securely and provided solely to members of the research team.

At the conclusion of the study, the participants were provided with information regarding the advantages of the HMIS, updates about data entry, basic statistical analysis on determining simple means and proportions, as well as an understanding of data.

Limitations

This research depended on self-reports and therefore faced the possibility of under-reporting and over-reporting HMIS and data entry tasks.

Additionally, the anxiety of being questioned or observed for providing certain information might lead to information bias.

However, to reduce the impact of these circumstances, participants were guaranteed anonymity, confidentiality, and the privacy of shared information.

Respondents timing and geographical locations of the HFs, and the lack of data from private health facilities to tell the complete stories of the malaria situation in the country was another significant limitation.

Health information systems importance in diseases

Again, as indicated *"that in research Nothing exists until it is measured…."* (Carla AbouZahr et al, 2005). As referred to in health systems and planning, only data can ascertain the measurement and progress in any health system interventions, including details for decision-making and strategizing. It was also asserted that effective health system governance necessitates dependable, timely information from a system with quality data (Carla AbouZahr et al, 2005). Decision-makers and stakeholders in the health sector need to determine if individuals are receiving the necessary services and where resources are allocated (UN-SDG, 2015). Furthermore, the function of a HIS in the health system will assist in guaranteeing the generation, analysis, distribution, and utilization of trustworthy and prompt data by decision-makers across all health system tiers (Carla AbouZahr et al, 2005).

With this comprehension and the significance of data for global health planning, this chapter explores the results and suggestions in the Health Management Information Systems

(HMIS) for decision-making in Liberia, focusing on malaria control initiatives and interventions. Particularly, the consequences of possessing quality information systems for planning that will allow the Liberia health system and implementers to comprehend and quantify the extent of the work required and make sound decisions regarding health priorities through data-driven choices and how to distribute resources for the most efficient and effective outcomes (UN-SDG, 2015).

This will allow nations and implementers to comprehend and assess the extent of the work required and make sound choices regarding health priorities through a data-driven decision and how to distribute resources for the most efficient and effective outcomes (UN-SDG, 2015).

Conclusion

In conclusion, it is thus essential that enhancing health information systems is vital for creating a more robust and sustainable health system. Therefore, the findings from the Liberia health information system study will likely swiftly deliver important results regarding data quality and the significance of timely responses to needs by countries. This is particularly relevant during public health emergencies, such as the Ebola epidemic in Liberia. In addition, the holistic health management information system and processes that generate key data and information to enable decision makers identify major problems and health systems, needs to be better strengthened at all levels of the health system. These processes and systems will enable evidence-based decisions on health planning and policies very effective and possible, in other words this information will assist in allocating scarce resources to the best and optimal use in health and then reduce mortality rate in diseases. It is therefore paramount that sustainable health systems are dependent on effective and strengthened health information systems which is critical to creating a resilient health intervention system and providing a body of knowledge on why health management information systems and evidence-based decision-making might remain weak.

Implications

General findings

The age range of participants in this research was between 25 and 45 years, among the 155 individuals across the 45 health facilities (which could increase to 55 as additional experience for the study is required). These age categories make up the majority of the active, productive, and economically essential workforce within the population of health personnel and data analysts at the facilities and ministry.

A larger share of the respondents was from health facilities situated in suburban areas, while approximately one-fifth were in secondary and tertiary health facilities found in urban localities.

70% of the respondents had experience of working for five to ten years, whereas 30% were employed for more than ten years. The following discussions concentrate on the findings related to the research questions.

Impact of HMIS on malaria interventions and improving outcomes

This study findings indicated that the utilization of standard health information collected via the HMIS platforms to the DHIS2 is being used and in implications has been monitoring malaria intervention effectiveness and effectiveness of community case management of malaria that is paramount in malaria control (Reithinger et. al, 2024), community case management of malaria (CCM) has proven to be the most effective strategy in combating malaria mortality in Liberia (LMIS, 2022; WHO, 2022; Ashton et al, 2023).

Management of community base malaria interventions has been expanded in many settings in Saharan Africa, but there have been some challenges around data and data use, this is due to the lack of extensive data detailing the effects of these community-based

services and their regular execution either on a larger scale or in smaller community environments (Reithinger et al, 2024). Hence, the use of HMIS that has supported malaria interventions in Liberia and chart control measures by using routine data from the HMIS to track and categorize malaria disease and its control (Measure, 2018; LMIS, 2022; Reithinger et. al, 2024).

This research in it study further demonstrates that the regular HMIS data utilized by the country has also been employed to frequently and consistently evaluate the efficacy of different malaria interventions at both the community and national levels, though this assessment has regularly been carried out by the central MoH HMIS team and malaria team but would have also been very productive if the community level officers have some form of data analysis and control (LMIS, 2022; WHO, 2022; Reithinger et al, 2024). Though, using the HMIS routing as a very important exercise by the country to ensure that Implemented malaria interventions that remain effective have proven to be a significant success in controlling malaria, thereby producing the intended impact, and ultimately aiding Liberia in its advancement towards its national strategic objectives and goals (HPF, 2007; LMIS, 2022; NHP, 2007 - 2011).

Reithinger et al, in their study on the utilization of standard health data to evaluate the effectiveness of malaria interventions, has expressed how important if routine HMIS data is used correctly that leads to interventions due to successful uses in assessing malaria intervention effectiveness (Reithinger et al, 2024; LMIS, 2022). However, the article expressed the fact that to achieve correct use of HMIS some key and important factors need to be in place (Reithinger et al, 2024). The focus will have to be on two major factors, such as data demand (Reithinger et al, 2024). also advised that for nations to properly utilize

routine HMIS data for the appropriate purpose, the needs or demands for data must come from the majority or all health service delivery points, spanning from community HFs to tertiary HFs. Additionally, data quality indicators and preconditions such as data completeness, being current and timely, and being of high quality must be present (DQIP, 2022 – 2027; LMIS, 2022; Measure, 2018; Reithinger et al, 2024).

On the other hand, based on the fact that achieving holistic interventions for which effectiveness is assessed and addressed is expected to have a high programmatic coverage, and this has been achieved in Liberia which have a huge 923 HFs from 93 health districts report on the HMIS. This in turn supports to position or implement focused interventions at a high-quality standard with cascaded level of malaria disease interventions (Severe malaria, engaging under 5s, treatment targets, pregnant women, and so on) (DQIP, 2022 – 2027; LMIS, 2022; Measure, 2018; Reithinger et al, 2024).

How has the health management information system developed and evolved in the past five years?

For the last 14 years, which includes the years of study focus (2013 – 2018), the Liberia ministry of health has been gathering health data, such as malaria intervention data, using the HMIS platform (Measure, 2018).

Though collected data is yet to be fully utilized for policy making and health planning that creates blueprints for key national disease interventions for funders to key into or advice funders (even though the country is now being supported by Measure Evaluation and other donor support agencies to develop key national documents that supports planning and interventions) (LMIS, 2022; DQIP, 2022). Amongst others, these are very key documents

that will support planning because if data flows from communities to districts and to central level it advises key intervention and reduces mortality

Knowledge of the HMIS

Information gathered from the assessment of this study showed that respondents' knowledge was generally good as an estimated 80% of the health staff and workers are generally all aware of the HMIS except facilities that do not report through the District Health Information System platform. This assessment also revealed robust knowledge and understanding of the core principles of the HMIS, as the reporting rate on the HMIS platform shows an over 80% facility reporting (HMIS, 2023). The other, under 20% of facilities that do not report directly on the DHIS2 platform utilize paper-based HMIS tools, which are sent to the central district hub for entry into the DHIS2 platform. Therefore, the majority of the health workers and data officers have all basic ideas of the HMIS tools based on what they were told to do and not necessarily be training. Some of the staff and senior health workers interviewed through a key informant interview expressed their opinions on the HMIS below:

"*This HMIS system serves as a platform or a resource to collect information to enable us to understand the total number of patients accessing different health services*." Response from a primary health care Community Health Extension Worker (CHEW)

"*The HMIS consists of different data that is gathered from our various units within the health facility, and these units individually collect data independently, which is then sent separately to the local government M and E unit because we do not enter it into the systems here*." Response from a secondary health facility Pharmacy Technician

"*The HMIS to my understanding involves data facility data entry into the system. All information will be input into the computers for correct and adequate storage of the different health services we provide, but the issues that I still contemplate are what will occur when the computers shut down due to power shortages as is often the case. Does this mean all the information will just disappear?*" response from a facility-based CHEW

"*We do not really know or understand much about this system, but we have heard of it. The little we know is that we collect data from our community work and give the data officer to use, most of our other team here even though we receive compensation to perform the work (enter data into HMIS forms) and consent to provide the necessary information. We do not even comprehend what we are doing other than merely populating data, and this is because the wrong people are trained for the job. If they know the system and feel we are needed, why don't they allow us to take over so we can perform the tasks when they are on leave or for any other reason? Everything comes to a halt when they are gone and naturally, we are engaged in our usual daily community activities and cannot leave them for HMIS or else patients will express dissatisfaction and you generate unnecessary panic and backlog, it results in more work for us and no rewards. All for nothing, no recognition"* A response from a junior health workers at the facility during the FGD processes with participants.

Attitude, practice and utilization of the HMIS

This research also collected information on the perspectives and practices regarding HMIS usage from FGDs, revealing an average outlook and approach towards the HMIS and data collection. The participants stressed and believed that since the data clerks were specifically trained for their roles, as well as being compensated for the data entry, they should perform the tasks for which they receive extra pay. Despite this, there was a consensus that the HMIS was crucial and essential for all aspects of PHC activities that document their fieldwork within the communities, although these focal health care officers often felt excluded from participation in the HMIS. These health workers indicated that this feeling was particularly strong when they expressed a desire to understand the system and were dismissed by those in authority. According to the conversations, these focal health workers appeared to be a significant factor in shaping the attitudes of other health workers towards the HMIS. The focal health workers sensed that their colleagues who handle data entry conveyed an impression of being more significant than they were, believing that only they should manage the NHMIS.

These responses were also emphasized by the respondents.

"*I attempt to envision or consider whether these data entry staff truly understand their tasks. Often, they find it challenging to understand those abbreviations on the forms and even request advice from some individuals like us who have not been trained in utilizing the HMIS tools. We end up supporting them and completing the work they are being paid to do, and the challenge is mostly when they go on leave or travel, who will carry out the task or whom will these officers assign it to? I can envision the type of information they will forward to the LGA.*" a response from a Facility nursing officer in the group.

"*The truth is we do not perceive anything difficult in inputting data, just that the way it's been handled makes it to seem difficult. The HMIS is for our own good and should be seen as such, it will and should make things easier for us to plan with. The conclusive information following collation is intended to provide us with guidance on how to strategize and make choices based on insights regarding our health centre, yet unfortunately the feedback mechanism is very bad. But we cannot force ourselves on the process as we can only assist if we are needed, thus, the data entry personnel believes that we intend to lessen their portion of the stipends they anticipate receiving.*" Response from a primary health care nurse

"*Data gathering and the Health Management Information System (HMIS) overall is an excellent concept and an effective strategy for health development and is never a misuse of time. What we are striving for if we lack awareness of our origins and our destination, it is truly important for us to understand where we are headed and how successful we are in achieving that goal. At a minimum, all the data we record in those logs each day should hold value. However, even though we do not have the DHIS2 platform in our facility now. It would be beneficial to comprehend the processes and applications of the data, as well as their significance and implications, and how they can enhance our work methods. Therefore, we are keen to learn, even though understanding and inputting that data with the HMIS tools is not a straightforward task.*" A nursing office's response

"*Using data, you do not understand is very difficult, you cannot use data you do not know how it came about. We ought to receive guidance on using the HMIS tools in our health initiatives, just as we understand our immunization and malaria coverage rates; this data will enable us to make informed decisions regarding which communities to focus on and how we can enhance our health education and the number of vaccines we should request from the ministry in our planning. The DHIS2 data will additionally assist us by providing quality information to oversee how our antenatal and delivery services are performing so we can promote health centre deliveries to mothers during visits and communities*." A community health care CHW lead response.

However, in spite of the significant efforts made by international and donor agencies during this time on the HIS development and implementation, the system continues to present several challenges due to various factors such as inadequate IT infrastructure, poor

road networks, insufficient and inconsistent power supply for data transmission, and, most critically, inadequate human capacity development to effectively manage and enter data. Fewer than 30 percent of the participants in this study had any exposure to HMIS training, and only half of these data entry clerks had received training within the past year. This was supported by findings from the qualitative sessions where participants indicated that only a small number of individuals (Record or Monitoring and Evaluation personnel and/or data clerks) had undergone training and failed to share this knowledge with other healthcare staff.

This has ultimately led to a perception of indifference regarding data collection and analysis, as respondents indicated that those who were trained and given additional stipends ought to be the individuals responsible for gathering the HMIS data for which they are compensated (FGD session). According to reports from the IDIs and KII, only a small number have received training and have yet to be updated because of insufficient funds. However, these few are anticipated to relay this training to other health personnel in their facilities. However, it was observed during the interview that when donor agencies come with funding, a few health facility staff from the intervention facilities are selected and trained.

This deficiency has gradually resulted in unfavorable perceptions among healthcare professionals, ultimately resulting in inadequate practices and unintentionally causing a shortage of prompt and dependable health data, along with ineffective utilization of health information for health initiatives, as noted in the present research and numerous other studies (Esene, 2015; Kunimitsu, 2009). Similarities were also observed in (Nicole, 2007; Yaser et al, 2019).

Individuals involved in the HMIS are an essential part of the framework and have gained knowledge through the process over the last 14 years; the KII and IDI show that over the years, some capacities have been built on data entry and analysis, demonstrating how the health management information system developed and has evolved in the past five years. Thus, although the advancement of the health information system has progressed alongside the development of suitable human resources to foster new abilities and skills to some degree. The distribution of adequate resources and suitable strategies is crucial to sustaining long-term and consistent HMIS staff capacity and training to enhance the healthcare institutions' data needs and analysis for decision-making abilities in the HMIS processes and national planning.

As a beneficial approach to data and information throughout the study, the participants were knowledgeable about the essential HMIS data sets and this percentage. However, if not being guided, only half of the respondents could enter the data set into HMIS without transcription errors or lateness. This inadequate understanding of the fundamentals of the HMIS is not surprising and could be linked to the lack of training and updates. Because health workers must acquire the essential knowledge of their duties, the probable consequences are that they will fail to comprehend the HMIS registers and will enter data both inaccurately and incorrectly (Esene, 2015). This was confirmed in a study conducted in Honiara, Solomon Islands, regarding the precision of clinical malaria case reporting at primary health care centers by (Kunimitsu, 2009).

As highlighted by participants in the qualitative component of this current research, the majority of respondents were more focused on the daily health tasks at the PHCs. Due to limited staff capacity, they were hesitant to juggle clients and patient care with filling out the

HMIS forms. Since many staff members who do not specialize in data entry do not possess fundamental HMIS knowledge and an understanding of the various forms and their purposes, they will naturally feel uneasy managing HMIS activities, as also noted by Esene in the research on health facilities (Esene, 2015).

However, this could have consequences regarding inadequate data entry, inadequate data analysis, inadequate data presentation, and deteriorating data comprehension and quality (Esene, 2015).

Most participants exhibited a precise grasp of the reporting frequency, probably because of their engagement and hands-on experience with reporting frequencies and the HMIS tools used. Reporting regularities are also structured in a manner akin to other documentation systems for the country's diseases, like the national Integrated Disease Surveillance and Reporting system, where respondents obtain consistent education as students and healthcare practitioners. This Study in its findings again are in line with answering the question, "*How has the health management information system developed and evolved in the past five years*" that shows how the data and information system has evolved the national information system in Liberia for the past years, from an excel data gathering and compilation system without transfer to a data transfer system utilizing the Health Management Information System frameworks known as the District Health Information System.

This is a good development because poor data transmission processes and lack of good knowledge on the correct reporting and data utilization will result in the non-availability, lateness, incompleteness, and incorrect non-use of health data. This also embraces the alternative hypothesis.

H1: "*The health management information system has been pictured and used correctly*".

In regard to awareness and the significance of HMIS, the majority of respondents acknowledged the importance of the HMIS and the utilization of data for planning. Most of the responses from the FGDs and KIIs indicated by respondents were in terms of; the HMIS system measuring progress and monitoring health programs, especially for malaria, also that the data system has improved Regular patterns of data gathering via the use of the national health management information systems. This further demonstrates specific improvement in knowledge and the national data capture processes of HMIS that should be used for national health planning; even though the respondents expressed their opinions of not being 80% yet but it creates opportunities to address every specific knowledge deficiencies that can be achieved through a specifically organized in-service training program that will over time result in effective practices and smart application of the HMIS in enhancing the management of all health activities at the PHCs and the communities they support (Esene, 2015).

Additionally, in this research, the majority of participants possessed accurate understanding of data flow patterns and the importance of feedback in HMIS. This is encouraging, in that, if respondents' expectations regarding regular feedback on the data they have gathered and escalated to the next stage is received, the probability of them implementing and applying health data will be significant as discovered by other researchers (Esene, 2015). This will ultimately improve their capacity to make evidence-based choices that will lead to suitable health interventions. Parallels were observed in studies conducted by Yaser. et al and Esene of facility data assessment (Yaser et al, 2019; Esene, 2015).

How appropriate is the malaria HMIS data for malaria control decision-making?

Also, during the research, it became clear that the administrators of health facilities were more likely to possess a strong understanding of HMIS compared to other health personnel, as also noted in the (Esene, 2015) study on PHC and HMIS usage. (Esene, 2015). This connotation showed significance because the leaders of health facilities were more trained in health information systems. Not all other staff are engaged in the day-to-day data activities. The FGD responses noted and stated by the heads of health facilities related to the research was that "*there is still a considerable distance to cover in reaching the goals of utilizing data for decision making"*. This pertains to the research inquiry regarding the extent to which the malaria HMIS data for disease control has aided in decision-making, also most *of the data managers mentioned that "there has been remarkable achievement in data collection, but the objective of data usage has only been achieved at an estimated 50%*".

This 50%, according to the findings, is skewed towards the donor-funded organizations that must submit data and progress for planning. With this understanding from the senior level health workers, the junior level health workers might not have the same and so may have some form of not too encouraging attitudes to good practices especially that other older health workers are supported by donors not lacking support like the junior workers. Another very important factor to this enlightenment for this finding is that other respondents who are also health personnels involved in everyday data assignments are designated health staff such as healthcare officers responsible for documentation and public health outreach workers supporting HMIS focal persons at the PHCs and data clerks at other facilities. Hence, some negative implications exist to data processes and systems because

whenever these trained focal people are not available or unwilling to continue on the job due to role re-assignment to other health facilities or positional upgrades that leads to vacant data entry positions; then HMIS process and structure may collapse (Esene, 2015).

So, capacity enhancement through training and refresher courses could greatly inspire the health staff to generate quality data with refreshed and enhanced knowledge. of HMIS structure and implementations (Esene, 2015).

Though the sentiments of the project managers and supervisors are somewhat negative during the study, especially around the weak capacity of the data officers (clerks) and the difficulty in paying their salaries as indicated during the FGDs and KIIs, the implications for these weak capacities and no wages is that the data capture and transcriptions will be delayed and encourage false or late data entry which will affect the accurate data picture of the country for planning.

However, the selected and trained data personnels and health workers have the mandate of sensitizing and retraining other personnel on data gathering and application at various tiers of health care and hospital systems that they are based in. These findings show that the alternative hypothesis that says Ha: The developed health management information system is reliable and appropriate for malaria control decision making. It is reasonable and accepted in this study but needs more capacity to push to attain its full function.

This, in its consequences, could greatly enhance the chances of a higher number of the other health personnel possessing a positive outlook and effective practices compared to the facility leaders if managed properly (Esene, 2015). Though, it is expected that facility coordinators or lead, having understood data systems and their data process and use due to a number of years in health systems, must have obtained such experience with a positive

attitude and good practice that will further strengthen the staff capacities for better results. But this is not the case as their role includes delegating assignments, supportive and supervisory roles are not handled as expected and these older staff are not directly involved in daily data entry. Thus, facility health data collated is used for summarizing and collating mainly for onward reporting at that level by these senior officers. However, to strengthen data understanding at the HFs, analyzed health data as charts are displayed on boards around health facilities in diagrams to further assist staff to understand data analysis and complete utilization to guide health decisions at that lower level. This also has Implications in national programming and disease control; if data analysis and use are practiced at the lower facility levels through the analyzed data, this process will strengthen the country intervention systems using a down-top methodology of understanding data/information for proper interventions decision and planning made.

It is important to note that suburban health facilities (PHCs) are headed or led by community health officers and Community Health Extension Workers or volunteers, as the case might be. These groups of workers who gather this information to create requests demonstrate responsibility and proof during assessments of health systems (by the overseers and funders of these initiatives): usually through the county ministry of health officials), however, in the city environment, most of the ill obtain healthcare from the larger government and private health institutions, which represent the secondary and tertiary levels of healthcare as also noted in research conducted in India and Pakistan (Esene, 2015). Also, health is sourced from privately owned hospitals. This is one of the vast limitations of the study because the national malaria control program needs to get complete data from the

private healthcare system that even includes pharmacies. Further, no existing structure that collects the personal malaria data was identified, not on the HMIS.

Effectiveness of the National HMIS

Regarding the effectiveness and reliability of the national HMIS, how has using HMIS data supported planning in malaria prevention and control? Just like in similar studies such as (Lippeveld et al, 1997) on making Health information systems work. 85% of the study respondents alluded to the fact behind HMIS being worthy of the practice and effort put into the process to be developed, again referring to the responses that “there has been remarkable achievement in data collection, but the objective of data usage has only been achieved at an estimated 50%”. However, these findings were a little different and divergent to views that were expressed by some research respondents who are junior data officers, such as clerks during the FGD sessions. The consequences of these existing resentments or unfavorable attitudes and perceptions might gradually establish a norm within the health workforce and diminish the currently existing benefit of an overall positive attitude, ultimately deteriorating the practice, use, and execution of the HMIS at the different health facilities (Esene, 2015). Again, about 15% of research respondents claimed that to have been very busy, and HMIS data reporting system could take a lot of time in processing. Hence, it a reward of stipend would increase their readiness to use HMIS for reporting due to reward for writing but a penalty for not carrying out the work could also be demoralizing to staff.

Practice and data utilization of HMIS by respondents.

During the focused group discussions to determine key factors that affect major practice as regards HMIS procedures, research participants were collectively not really up for it and a little demotivated in this district. Research respondents explained how they are not really involved in HMIS data collection and transfer, hence they are not acquainted with the processes and lack a sense of ownership of country's HMIS and its systems, because only the data officers know everything and will not even listen to them. These health data officers conveyed that their positions were merely utilized to gather information for individuals in superior positions within the data collection hierarchy and were not receiving proper acknowledgment with no incentives; this was also the case in some earlier reviewed literature in Nigeria and India (Mahmood & Muhammad, 2010; Esene, 2015).

Most of the data officers involved in actual day-to-day data gathering, collation and transfers were already trained but still need some training on HMIS as their data use knowledge has not been improved in the last four to five years as this study reveals. The data officers in their roles are to support in trainer of trainers' activities of HFs for us but that is not the case as expressed by a data staff, another officer claimed this would have helped them and other health officers of interest for easy understanding and continuous involvement in data demand and maintaining health information at facilities.

As a boost to the HMIS processes, most of the data officers were aware and had good understanding of data entry to the HMIS and its data collection processes as observed by this study, even though it was observed that the distinction between the data officers and the other health officers was very obvious in understanding the HMIS and data input. Most of the data staff and clerks appeared to be clear about the forms, abbreviations, and there were not many

criticisms of complexity or multiple data collection including registers tools being used at HFs. However, it could be very cumbersome at the HF data collection point, especially when collecting data about different diseases and collating from different facilities to be summarized with the hub's existing job description of these staff at the health centre.

One key factor mentioned as a challenge as highlighted during the FGD was poor financial incentives to the data clerks, lack of supervision, and most importantly feedback from the central and regional are very minimum but there is quarterly meeting that some of the facility heads attends for feedback. Though, this feedback according to the health workers do not get to them. Some of the comments made from the participants are recorded below:

"*As health workers and facility leaders, we ought to receive training to grasp at least some aspects of the HMIS processes; in reality, we do not have adequate training for this HMIS. Additionally, individuals who have received training require updates and retraining, and we are quite certain this is the reason data officers occasionally face challenges with data entry. Entering data into those NHMIS registers can be tedious or challenging due to the numerous entries involved*". An assistant nurse at the health centre.

"*In this HMIS data entry, because it takes so much time, I think incentives are very important issues. We should be encouraged because all our efforts in Data entry within the community are particularly challenging as we need to integrate it with our daily responsibilities at the health centre, and you might already feel quite exhausted after working that day yet still be required to complete it. The financial rewards will bring us joy and motivate us to continue with data entry, knowing that our hard work will be compensated*". CHW at the district facility.

"*Even if the health ministry lacks the funds to train us, they can at least visit us to see what we do and how it is executed or, at the very least, provide mentoring. If they visit, they will be able to listen to some of our difficulties and resolve them. Otherwise, how can the ministry be certain that the data is entered accurately and appropriately?*". Response from a nursing officer

"*I do sometimes get frustrated about putting in a lot of efforts and technical challenges faced gathering these data for the HMIS and its entered, there is no form of any feedback gotten at all on the issues around the data either good or bad and the impact of what we are doing. It is very discouraging and not fair on us as field workers in this sense. Also, because the senior officers are the only ones that understand the HMIS and the systems*

due to the fact that data is transferred through them, we don't really participate in health decisions being made aside sending in data". Medical record officer's response.

This study has used In-Depth Interviews to further investigate key roles played by PHC health data support staff and the understanding of data use among the senior health officer of the malaria programmes, Also, how the MOH guarantees quality data right from source (PHCs) to regional and central level of data flow pipeline. The national health strategic framework 2023 emphasized the importance of training for all health workers connected to data gathering or not, this was made important and a first point of call to strengthening the health systems through quality data.

Further, the national health strategic framework 2023 also expressed that when health workers who are involved in data collection process in the data flow pipeline or connected to patients' data are trained (with no limit to a few sets of officers). This process of training or retraining will support the health system and erase negative attitude towards the HMIS and data collections. Again, this process will provide a leveled platform for health staff and data experts with a system that guarantees the presence of personnel that consistently fills gaps and ensures that high-quality data is gathered and processed accurately and promptly. The national health strategic framework 2023 also emphasized the need for feedback to field and HF staff on data performance for health facilities and so appraisal for staff its activities can be conducted and appropriate timely health decisions to improve interventions at the communities could be achieved. As stated in the 2023 framework (HSF, 2013)

During the key in-depth interview, some responses were recorded as stated below.

"*Data gathering and collection must not be restricted to a single individual who is solely the data officer. They make the whole system to be dis-functional when they are indisposed for one reason or the other. No officer will be inclined to adopt extra*

responsibilities and oversee data collection, particularly since we all understand that the individual in charge of data receives compensation for this task and no one else has been trained for this role.". County Health Officer.

"*High probabilities for disruptions may occur in the data gathering and transmission if training and retraining do not always occur. These officers are not regularly trained; only selected officers go again and again with no step-down activities. I will propose consistent visits and oversight from the LGA monitoring and evaluation units along with the HMIS unit of the MOH. During these visits, officials from the ministry of health can conduct a brief on-the-job training session for all personnel, which will also be more economical for them if insufficient funds are the reason for not training everyone engaged in data collection"*. Response from another county medical officer.

"*What is the advantage or the core purpose of undertaking all this effort in gathering and organizing data and stressing yourselves when you do not receive feedback on what has been gathered? Is this HMIS data not intended to be a significant health resource for health initiatives and planning to enhance the lives of the communities we support? The HMIS unit of the ministry of health above in the data flow channel needs to be trained and re-oriented that the essential insights obtained from this data, in addition to assisting the data expert in developing and steering health policies, it is through returning down the data flow pathway that these health policies and health actions can be executed.*". Response from another county medical officer

Key informant interview

The Key Informant interviews were conducted to verify comprehension concerning HMIS enhancement and the difficulties associated with improving data systems via the training and capacity development of health officers involved in malaria data collection at various levels of health services across the nation. A senior member of the ministry of health disclosed how re-training has not be reconducted for the old staff and no training for new data entry staff yet (over one years in some district could be more in others), though limited health staffs have been trained in the past one year but health officers are meant to be regularly supported with training because of continuous data entry. There should also be a system to continuously update data experts and officers on HMIS improvements in

partnership with donor partners and funders, this will help support health teams at health facilities across the country for data cohesion and use.

"*The Ministry of Health has just hired and trained new Monitoring and Evaluation / Medical Records staff, who are meant to be at the county health secretariat and guarantee continuous data gathering from the health facilities and subsequent transmission to the central as well as regional levels via the DHIS2 platform. For facilities lacking computer systems, the paper-based forms are transported to the central facility (hub) at the district for input into the HMIS2 platform. The ministry provides stipends to data clerks and record officers for the purpose of recharging their modems and ensuring that these data are entered promptly so they can be accessed at the HMIS central office"*. Response from a monitoring and evaluation officer.

"*I concur, and it is evident that there are numerous opportunities for enhancement, and this will be realized if an appropriate and distinct budget is allocated for the HMIS, as insufficient funding for human capacity development poses a significant obstacle to accomplishing our objectives here"*. A mid manager from the MOH.

"We are confident that we understand what actions to take and what is required of us, and with increased and consistent backing from the Government via the ministry of health, everything will come together. I believe the governmental political will (which now includes the HMIS ministry) to recognize that having access to high-quality and current data is crucial for planning and resource distribution will attract the essential focus and funding needed to invigorate and propel the system". Responses from a top staff of the ministry of health.

How has using HMIS data supported planning in malaria prevention and control?

This research in its results demonstrated that the dependence, engagement, and amalgamation of information that currently exists among the tiers of health care and data gathering could assist in promoting and improving the understanding, methods, and data employed by health professionals through appropriate oversight (from the rural community facilities to the urban health facilities) along with participation in joint local actions at linkages between the interventions and the program planning through health facilities. This is noticed from the responses during the FGDs and KIIs, where respondents' perspective seems to be a limited view regarding the significance of data and its application; the majority

of the respondents across the classifications highlighted that "*the main use of data is to help the country develop proposal for funding from donor partners*". This, in its implication, is not supposed to be the case and has, in some ways affected the primary utilization of data; the process is now seen as just a data collection routine. In addition, a few respondents believe these beliefs are vital factors slowing down the growth rate in providing quality and timely data through the HMIS as long as the mindset is skewed towards believing that data is captured and/or collated to get funding from partners.

However, observed during the study findings was that more respondents (data clerks and supporting data entry volunteers) with poor knowledge of NHMIS use gave the impression of the country gathering data because of proposal writing or fund request. This was highlighted in the FGD sessions where participants expressed that they gather data because they are instructed to and can only provide what they possess. Even those who strive to gather data accurately do not receive any feedback regarding the nature of the data gathered or its intended use. This indicates that the feedback mechanisms within the country's data flow systems are deficient; the consequence of this system suggests that the ongoing cycle of producing low-quality data may persist. Since health personnel who collect this data do not comprehend and trust the information they gather, they are less likely to make use of it. This will perpetuate and exacerbate the negative attitude toward and non-utilization of the collected data. affecting the health systems' decision-making.

These findings also revealed that apart from the abovementioned challenges, the data collected has an improved monthly transmission rate to the central level of 85%. As discussed earlier, there might be areas for improvement in timely reporting and staff capacity. Still, data is gathered through the HMIS and stored correctly at the centre through the HMIS

storage facility and hard drives. The implication is that data is accurately collected and stored, which is a huge plus to a country's data system; this will strengthen and respond to the research question of how the utilization of HMIS data aids in the planning of malaria prevention and control? At the least, the country has data for planning and can only improve effective planning. And this indicates that the national malaria intervention decisions have been made from the national HMIS data, the only platform utilized to collect malaria information and for strategizing and making decisions. In other words, the alternative hypothesis **Ha:** Decisions on Malaria prevention and control have been made through the use of valid HMIS data is accepted. This also is in agreement with similar research in Gambia by Ceesay. *et al.* 2008), where an unprecedented decline in malaria incidence was acknowledged from the HMIS usage in the Gambia even though not in the whole operation.

Health facilities HMIS data use from the Districts Health Information Systems (DHIS2)

The study engaged data entry staff, which could be clerks, HMIS officer, medical officers or monitoring and evaluation officer according to nomenclature of the officer entering data. A focused group discussions with data collection and entry staff was used, a number of interviews were also carried out with essential personnel responsible at health facilities to gain a deeper understanding of the data. use and how HMIS data from DHIS2 has supported planning at the health facilities, health districts, counties and the country. The responses of the data entry officer regarding matters of data usage were documented. The officers communicated that data ought to be utilized for various constructive purposes, such as the registration of patients, which will allow the district health and facilities data users to identify usage and potential excesses that should be limited at various health facilities. Every

HMIS and data entry staff member who was interviewed indicated that data offers insights that assist and support decision-makers in planning various interventional activities.

Additionally, the medical officers indicated that the information derived from data analysis assists in monitoring indicators by generating graphical reports in the form of charts for various programme coordinators, including the Community-Based health workers, nurses, Health facility coordinator, and community diseases coordinator. Nevertheless, a primary concern raised by the medical officers was that data from the system had not been and still is not fully utilized as anticipated, and thus the HMIS data remains underutilized. Furthermore, they noted that program planning and decision-making related to interventions has been sluggish compared to other areas, such as human resources and drug distribution, which fully leverage HMIS data for informed decision-making. This situation has led to several challenges; consequently, some departments overestimate the quantities of drugs needed based on their own calculations, as mentioned by an HMIS Officer.

In other interviews and focused group discussion, data use understanding according to monitoring and evaluation, medical officers, HMIS officers and facility coordinators were also recorded. These medical officers and facility managers also conveyed that data should be utilized for multiple purposes, including the registration of patients concerning visits and admissions, which will allow healthcare facilities in various districts to utilize data in order to ascertain the usage and potential intervention trends for different disease areas at health facilities. The monitoring and evaluation officers and other data entry staffs also stated that accurate data provides key information that supports decision making and key policy formation, but a very key gap is the non availability of a feedback mechanism that enables corrections and planning of different activities very effective and productive through.

Furthermore, the feedback assists to check indicators if they are well reported and made analysis meaningful. In addition, the officers stated that production of reports from the forms and registers too could be very cumbersome and therefore cause a lot of data transcription errors that could mis-inform decision. Though, that there is no doubt if well collated and transcribed using graphs and other methods for different programme coordinators, it will further strengthen the program and quality data will continue to emerge.

Data challenges

The challenges faced with the Health Management Information Systems (HMIS) at the health facilities in Liberia and in terms of data management were reported, discussed and stated below:

Registers: The standard Health management Information systems (HMIS) form have less indicators than those contained in tools (forms and registers) used by data entry officers and Clerks at the healthcare facilities to gather daily information from the health staff. In this instance, the data sent for submission to the HMIS unit is conspicuously lower than the data produced or generated at the healthcare facilities that are sent to be recorded in the system.

Data Accuracy: The data entry officers (HMIS Officers) expressed dissatisfaction with data accuracy and indicated that a few discrepancies exist in the data, as different tools are used by different data collectors on the field and facilities to generate data or collect data. The research confirmed this issue by analyzing and contrasting the tools used for data collection at the district level, health facility staff, field healthcare workers, and program coordinators, all of whom were found to define indicators in varying ways. This resulted in

discrepancies in the interpretation of the indicators among the various personnel, which poses a significant gap in data quality assurance.

Capacity of staff: Another gap identified that has caused discrepancies in data and reporting is claimed to be the inability of the system to build capacity of staff for lack of capacity in gathering and merging data from various data collection sources to remove duplicates, minimize transcription mistakes and manage entries accurately. This issue was noted as a frequent challenge among facilities and supervisors; for instance, records of the same patient provided by a field health care worker and health facility staff may be recorded in the HMIS as two separate patients because of insufficient capacity and a lack of comprehension of certain tools.

Timeliness of reporting: On of the major issues identified and still an issue in the country is the challenge of timely reporting and completeness of report, late submission of reports, data inconsistency and data misplacement due to last minute rush, made-up data, are all discrepancies that were said to typically be experienced when creating monthly reports for quarterly summary reports. several factors may contribute to this delayed submission or tardiness. for instance, certain health facility personnel in remote rural regions that are difficult to access encounter challenges for data collectors like the data entry clerks to take their data or forward to their supervisors or the hub where data is entered or to be compiled at the health facilities, and subsequently sending their data to the HMIS unit in a timely manner becomes difficult citing logistical constraints (such as vehicle or transportation). This indicates that insufficient resources regarding transportation for gathering data from the field or from difficult-to-access regions to the central health facility, and ultimately to the

district health office and HMIS unit at the national level, also play a role in the postponements of data compilation in the system.

Electricity Power: Power outages and malfunctioning computers at the district level, which require prolonged repairs by the Ministry, were identified as one of the major issues encountered during the study. Consequently, some health facilities in districts are presently establishing their own databases using Microsoft Excel to compile data in order to prevent data loss and ensure effective data transmission. Furthermore, even though these databases are not standardized, potentially resulting in inconsistencies, the data entry personnel assert that they only input what is necessary into the HMIS. Despite this, one data entry officer mentioned that the temporary databases created might vary somewhat among the districts, and there is a need for supervisors to harmonize them.

Data reliability: The data entry officers were requested to share their perspective on the reliability of data collectors. Reliability is defined as “the extent to which we can depend on the source of data and thus the data itself” (Kasambara et al, 2016; Davis et al, 2007). In this research, reliability was assessed on a scale ranging from 1 to 10 (1 = not reliable, 10 = very reliable) in order to determine the average perception among health workers, and an average reliability score was computed for each data collector (Kasambara et al, 2016). It’s represented on the table below.

Table 18

Data Collectors Reliability Test

Data CollectoR Kasambara et al, 2016).	Estimated Average Data Reliability (Kasambara et al 2016).
Monitoring and evaluation officers	9.5
Data entry clerks / HMIS officers	9.5
Health surveillance assistance	8.5
Medical officers / Clinical Officers	8
Nurses and health Coordinator	7

Problems associated with HMIS Data Collectors Reliability test (Kasambara et al, 2016).

The HMIS supervisors reported that the information from the monitoring and evaluation officers has an average reliability of 95%, while data from data entry clerks and health facility HMIS officers comes next with an average reliability of 93%, even though there have been no staff trainings at the health facilities. In certain health facilities, the number of data entry clerks, nurses, and health care workers was limited, which may have affected the reliability of the data.

Again, one important and notable aspect of data quality as outlined by Davis et al, is accuracy which assesses the correctness of data (Davis et al, 2007). The HMIS officers participating in the study were further interviewed on questions regarding the precision of the information provided by various data collectors, 7 out of the 10 HMIS officers surveyed at the districts said that the data received from community care workers and other filed workers was on average 65 to 70% accurate as analyzed by the HMIS supervisor, and the other two officers had a neutral stance regarding this issue. The concerns regarding accuracy were believed to be due to several factors that influence data, including data completeness, as the forms and registers indicate

that there are certain missing values, and another factor was the insufficient training of data collectors. One monitoring and evaluation officer mentioned that “Familiarity with some terms on the forms and registers by the data entry clerks or HMIS officers, depending on the case, who is compiling the data” might be another aspect that contributes to data inaccuracy at the health facilities as also described by Kasambara et al. in the study on “Problems associated with HMIS” (Kasambara et al, 2016).

Adequacy of data for decision making and planning for district data use

The data gathering and investigation at the health district level from health facilities might represent one of the most important information sources for interventions for diseases, if properly and adequately handled. Interview with a health district coordinator on data use, the health coordinator explained “*Due to the restricted quantity of indicators for their particular programmes, the information from HMIS is not thorough or sufficient for efficient planning and decision-making”*.

However, on data use, the district health coordinator also emphasized that this type of data is because of its gathering routine is quite beneficial for overall tracking of service provision, strategizing, and high-level intervention preparation. Ten (10) HMIS supervisors were likewise questioned through a targeted group discussion. Five (5) of the ten supervisors stated, “*The use of information and data at the district was sufficient for their particular program planning as it enables them to observe the patterns in health service delivery and disease occurrence at that level*”. However, despite the emphasis on inadequate data being experienced at the health district levels, four (4) district health coordinators and the earlier interviewed data entry supervisors claimed that “*Various choices and strategies were being developed using or relying on the health facility HMIS quarterly summary information report*

that was on data distributed. Some of these decisions and planning involve departmental plans, district health premeditated documentation that includes strategies and district yearly execution plans to direct partners in the district on program strategy, inoculation plans, community engagement and growth and disease outbreak response as stated by the health district coordinators.

Adequacy of indicators in HMIS

Another very significant gap mentioned during this study in the accuracy and adequacy of the indicators on the health management information systems, some study participants mentioned that the indicators do not cover all activities exhaustively (however it's good to note that the HMIS includes many other disease areas aside malaria which is the study focus). Therefore, each health program such as the malaria disease necessitates a specific assessment and monitoring thus necessitating a particular program data, thus requiring a targeted collection database, but the malaria disease is solely dependent on the HMIS using the DHIS2 instance.

What will determine the supporting factors to effective HMIS strengthening for malaria control in the country?

The objectives of HMIS, as well as the knowledge and application utilized by HMIS officers

The goals of the health management information system as outlined by researchers involve gathering, organizing, analyzing data, and sharing information while guaranteeing

that the data is comprehensive. and consistent with intervention for proper decision making (Mehmood et al, 2010). (Mehmood et al, 2010), further explained that the system analyzes the information that offers insights to verify health indicators and generate reports at suitable times to allow decision makers or managers to strategize efficiently and formulate policies (Mehmood et al, 2010). (Mehmood et al, 2010) additionally contends that the HMIS framework supports monitoring and evaluation to evaluate the health systems' advancement during and following implementations. (Kasambara et al, 2016; Mehmood et al, 2010).

This study further engaged the HMIS officers to gauge their understanding of HMIS objectives achievements over the period of the study and now, the HMIS officers remarked that “HMIS data for them has been reaching an average of 90% when it comes to health facility usage for data collection and some extent of planning but that unfortunately the feedback is poor from the top”. In achieving the other parts of its objectives such as completeness for analysis, the HMIS officers stated that the factors preventing HMIS from reaching 100% were related to delays in obtaining data from facilities and most especially from the communities of hard-to-reach areas. The HMIS officers also emphasized the lack of training or capacity building as a very huge and significant factor, which, if tackled, will accomplish the highest goals and deficits in communication among departments peer sharing.

For example, the HMIS officers observed inadequate data sharing between their office and their colleagues from other districts; rather, the officers merely gather and send data to the central platform for elevated Program planning. Consequently, it was perceived that program planning choices were occasionally made without considering HMIS data at both the district and community levels, as program officer would have collated their own

data and transmitted before it can be reported as inconsistent if issues arise. Hence, the HMIS officers pointed out that peer learning from other departments would have resolved inconsistency gaps before the central report is produced.

Other determinants for HMIS strengthening in malaria control

In the course of the study processes, an in-depth interviews was conducted among health facility workers and staff, where most of the respondents highlighted that the Ministry of Health (MoH) needed to improve or do more in ensuring that basic requirements are very much available and in place for the health systems and HMIS to perform its objectives and work at its maximum (the respondents referred to inadequacy of Internet and power as mentioned). Most of the senior staffs largely agreed to the notion that though manpower was adequate and available, the challenges dwells in the fact that the healthcare personnel that existed at the time of this research agreed to be primarily untrained and not fully aware of the usage and goals of the HMIS as the ministry of health would have wanted. As agreed by (DQIP, 2022 – 2027). Furthermore, it was mostly agreed by majority of the senior ministry of health staff that there was adequate supply of HMIS registers. This was a very correct statement as registers were found in 100% of the health facilities assessed but 90% of the health facilities have the current HMIS registers and tools, it was very evident because the malaria interventions were seen to have reported 90 percent reporting rates during the study desk reviews. One of the very significant downsides was the findings indicated that stationery was primarily supplied by the personnel of the health facility, considering that if the ministry of health or district authorities were to provide these stationeries, it might

motivate the health worker to collect data more efficiently and effectively as also identified by Esene's research on HMIS and HFs (Esene, 2015; DQIP, 2022 – 2027).

In addition, the comprehensive results from the interviews further clarified that besides the medical officers at the facilities, the monitoring and evaluation officers and records staff at the health department of the counties and districts facilities, only main hub of the 93 health district personnel possessed laptops with internet access for uploading and transmitting data on the HMIS, and the cost of servicing their modems was their responsibility, excluding the monitoring, evaluation, and records staff as also found out by Esene's 2015 study (Esene, 2015; DQIP, 2022 – 2027). Though, the Ministry of health has claimed that this present situation has changed or its changing as the officers now get stipends to service their modem occasionally (it is also clear that the modem belongs to the staff).

The medical officers during this interview also emphasized the erratic state of power supply as observed at the health facilities around most of the districts selected for this study. Though, most health facilities had either solar panel and generators available but also had erratic functionality and even in cases where generating sets were accessible, they were intended for the current laboratory.

A response from one of the senior health ministry units' staff, stated that. "*The system in its function tends to be improving by the day even though with some key challenges like electricity but will be resolved". Most importantly key sources like electricity, effective internet connectivity is currently accessible at the health facilities to prevent disruptions in data transfer and facilitate easy access to data from the national platforms, though there is*

room for improvement as it is a general problem and still at 70% coverage" An administrative staff of the health unit.

A medical officer at the district also expressed that "*You can imagine how the health personnel experience significant stress in remote and difficult-to-access community regions, going through all of these in order to submit HMIS data to the to a district hub to be entered in the DHIS2 platform. This makes it difficult for any health worker to take part in any other activity in the health facility for that day, this has become an everyday routine that tells on personnels productivity. Once more, this situation might have been prevented with effective internet access, availability of adequate electricity, good access roads, available and functioning computer systems dedicated to the data entry, HMIS officers and even provisions of logistics to the district hub if the officer must get there to submit the HMIS data forms*". Response from a senior medical officer

Key informant interview methods

This KII method of interview was engaged to further explore difficulties and gaps currently setting back efficiency and functionality of the HMIS flow from different health facilities and the recommendations to address these data gaps making a way forward. These key gaps and challenges emphasized for the malaria programme as indicated by participants was participation in HMIS and data flow that encourages ownership of the whole data and HMIS processes. Further, political will on the part of the county administrations was mentioned as a challenge aside from the support from the Ministry of health has resulted in an anticipated warning regarding the necessity for quality and up-to-date beneficial health data.

"*Despite the financial limitations of the ministry of health, the government in collaboration with partners have made it a very strong agenda to continue in strengthening the HMIS unit, most importantly that all health personnels demonstrates enthusiasm and shared intent to ensure the system functions effectively, as ultimately it aims to make the HMIS practice concentrated and productive in decision-making (Esene, 2015). On the part of the national malaria control programme and the Ministry of Health, a deliberate and strong political will is intended. This could make a difference or aid in addressing the effective practices of HMIS. "This political determination will assist in advancing the systems gradually through a greater comprehension that easily accessible, high-quality, and*

current data is essential in fulfilling crucial components of the millennium development goals". A top health officer's response.

HMIS in its processes and efficiency as also supported by other reviews will require respective institutional and educational support factors and changes to inculcate the right and efficient attitudes to use of data information and IT use, this process was carried out by the University of Oslo in 2010, according to desk review. At that point, the national health system deems it fit to decentralize the different processes by improving skills to interpreting data collected and use of IT that strengthens electronic HMIS rather than paper-based data transfer. This effort was deliberate to further enhance collaboration in data transfer and health management information systems among all tiers of healthcare provision facilities that produces intervention information from the lowest healthcare level (facilities), along with modifications in concepts, methods of thinking regarding information and utilizing information, were also carried out by (Measure, 2018; Esene, 2015). However, the MOH and the National Malaria Control Program envisaged that changes might not be achieved without good planning or overnight or forced down from higher levels to bottom but necessitates managerial dedication at every level and must be executed gradually while encompassing the gathering of resources and engagement of all levels to shift individuals' deeply ingrained perspectives on information usage progressively (Esene, 2015). This study was similar to the previous study carried out by (Cham et al, 2006) on the Gambia Health Information systems, identifying the determinants and supporting factors to effective health information systems strengthening.

Continuous training and the capacity building as agreed by the Gambia and Nigeria studies becomes very necessary to produce new meanings, techniques and work procedures of data

processing and use and thus evolve a new culture of information use at the local and county levels with the country in general (Cham et al, 2006; Esene, 2015). Previous studies on malaria HIS in the Gambia and sub-Saharan Africa rightly agreed on training being a very huge factor in HMIS and its structures (Cham et al, 2006).

Implementational application of HMIS for evaluation and performance of health systems that tackle shortcomings and obstacles in service interventions is believed by the country from findings of this study to produce paths to disease control that key into achieving agreed sustainable development goals (UN-SDG, 2015). The study made it very clear through the KIIs with the high-level managers and the MOH staff that the effectiveness of HMIS will depend on capacity building and utilization of data. This is said to have begun with donor agencies building the national capacities and the country's health system involving the primary health system through a wide range of consultations. Also, the government now has an HMIS office under the MOH where national funding is channeled to further strengthen health data in the system as a huge supporting to practical HMIS usage. The findings here agree with the alternative hypothesis Ha: that the health management information system has been pictured and used correctly.

Discussion

This study, from finding observed that malaria data were generated from different sources and facilities in Liberia, including consultation, hospital diagnoses, rapid community testing, and reported by the Liberia (LMIS, 2022). Hence, this multiple diagnosis is practiced in all teaching hospitals, secondary health facilities, primary healthcare centers and communities in Liberia (NHP, 2018 - 2023).

This study in its findings also found out that there are multiple accepted data collectors (community health care workers, nurses, HMIS officers, monitoring and evaluation officers, etc.) that collect data with the same HMIS tools but at different locations of interventions across the community and project sites. Further, this same sets of data collectors uses same registers and forms but around 15% of these facilities are still using some outdated HMIS tools as observed during the study. In a little digression even though this study does not cover other disease areas, it was observed that some other community intervention programs still do not enter data entered into the HMIS despite consensus among all stakeholders by the MOH on singular data route and reporting system. However, the focus of this study is on malaria intervention and data use which is completely dependent on the HMIS structure and DHIS2 electronic instance using the HMIS tools. Furthermore, there was an observation during the data gathering process of the study that some verification on data before input that needed to be carried out by supervisors at HFs were not monitored. Hence, entering data into DHIS2 instance from HFs points of care and services and other health was not being done due to shortage of human resources in supervision. The earlier plans by the Ministry of Health to mitigate these constraints were the initial plans to have a position of lead health facility supervisor at each HF and a reporting hub (a spoke and hub structure) to validate data before being entered to HMIS before further transfer to regions and national HMIS (DQIP, 2022 – 2027; Kasambara et al, 2016).

The health ministry in its report had recommended quarterly and semester verification exercises of individual records or semester On Site Data Verification exercises for completeness and accuracy (NSP, 2021–2025). During the study, HMIS officers and clerks interviewed emphasized the data discrepancies in collection and reporting, claiming

that late submission of reports has produced incomplete data causing a failure in the system that hinders proper aggregation of information from healthcare facilities and centers. This procedure of data verification by supervisors helps to eliminate data double counting and loss through transcriptions, hence due to such challenges data inconsistencies in collection and reporting were also observed being due to current delay in data submission and lapses in capacity building of health districts personnels.

The study recognizes the importance of data quality in data demand and use. The study found out that some entered data on the HMIS that are transmitted from health facilities to other levels were not validated and efforts are being made to be improved upon these processes (DQIP, 2022 – 2027). Data in some facilities of health districts were termed as incomplete and dubious regarding dependability for program planning; however, these same challenges are not peculiar to Liberia alone but also in eastern Africa (Kasambara et al, 2016). There were also other challenges recorded that relate to the private sector on malaria interventions, this refers to use of outdated data collection tools that results in challenges with consolidation of data for the country. These challenges and other critical gaps present significant constraints for data readiness, quality and data utilization for the development of policies to facilitate informed decision-making as emphasized by (DQIP, 2022 -2027). HIMS officers as participants interviewed have claimed that data retrieved from HMIS systems might either not be too comprehensive or adequate for anticipated efficient planning and decision-making due to insufficient quantity of indicators tied to specific programs, however the plan for enhancing data quality that was created has included these challenges to be addressed (DQIP, 2022 -2027).

Again, the study showed that Liberia healthcare sector and the Malaria control data are generated from the text recorded at community and facility levels, either structured or unstructured (LMIS, 2022). Diagnosing the structured aspect, it was observed that data is collected and classified as a significance to direct choices at different tiers of healthcare services. The study observed how critical this process is because some situations are considered more serious and important to track than others, such as data that determine mortality and morbidity from community health facilities and agreeing with argument by Iyamu & Mgudlwa that explained reasons behind data usefulness in utilizing its abilities from both technological and human resources (Iyamu & Mgudlwa, 2018).

On the part of capacity building, survey participants lamented and expressed limited supportive supervision, support training and reminder courses to improve health workers and data entry staff's knowledge. This has become very significant because findings from studies including this Liberia research have emphasized one potential factor that might lead to inadequate data quality from facilities could be the absence of facility management and oversight to review and rectify the compiled report prior to forwarding it to the subsequent level (Kasambara et al, 2016). Another key finding from this study was how data is transferred and managed resulting in facility challenges, the study revealed that the system is most significant challenge from the health facilities is delayed submission of reports from source documents of the facility to district hubs (where hub and spoke exists) due to remoteness of facilities or hard to reach areas and logistical constraints (e.g. transport to collect data from the field).

The study also observed district level challenges that affect data flow, this involves consistent challenges of electricity power failure or not being available but some hubs,

secondary and tertiary facilities are seen to have solar systems. Some faulty computers were also at the health facilities, these computers are meant for data entry and to produce reports for onward transmission to the next level. However, the Ministry of Health acknowledged that challenges and delays do exist in timely data reporting and completeness of report due to challenges with internet and computer maintenance at district and community HFs.

In the part of human resources for health personnels, study findings observed that most existing HMIS officers had minimum qualifications standards as set for districts levels (even though the standard was not too clear in written) to be qualified for position od officers or data clerks (the position is said to be for health workers statistics background) as advised and documented in (Liberia health policy and strategy [LHPS], 2018 - 2023). If personnels lacks key qualification prerequisites for data management, these data officers might tend to find it difficult explaining data trends for interventions due to limited knowledge of data analysis and use of information. In data management of health services at facility and district levels including the national malaria programs and interventions, it is very important according to Liberia HPS of 2018 to 2023 to have a standard knowledge of data and statistics (LHPS, 2018 - 2023). A quick insight was taken amongst stakeholders on data use, data informed decision and planning; most stakeholders that included the public and private hospitals, medical doctors and donors have agreed that data quality has to be improved upon and so to make correct decisions from data analysis. These senior ministry staff stated that "regardless *of all these challenges, the HMIS has significantly improved data gathering and analysis as the information is becoming more precise because HMIS data are collected at the point of service delivery, and there is a system in place where health facility management teams are required to gather data directly from the registers and compile the data in*

designated HMIS collection forms". Nevertheless, during the interview, the health workers tend to contend in disagreement that it may not be as accurate as presented or reported due to variations in data gathered through other parallel data systems of the same source, such as disease surveillance data and routine community data collection, just as opposed in the East African study by (Kasambara et al, 2016).

Recommendations for application

Some important recommendations are made by this study based on research findings, these recommendations made is believed that they will contribute to improving the HIS and further strengthen the capacity of the HMIS and DHIS if implemented and utilized in health facilities across counties on malaria control interventions.

This study adapted a case study design using a mixed method approach and triangulating at some stages because of the extensive nature of the data gathering and reporting system with the use of a national HMIS and other electronic medical records across the health system. The findings from these data gathering processes were used to engage quantitative approach that constructed other questionnaires to gather information through larger population sample for triangulation (Glaser and Strauss, 1967; Abawi, 2017).

In addition, to further strengthen the finding for recommendations, document review was also used to gather information about historical antecedents, evolution and functionality of HMIS to reveal the research questions.

This outcome of the study is anticipated to offer a collection of information on the reasons behind health management information systems and evidence that are based on key decisions that are made using data remain weak as recorded in the findings, how this process can be strengthened

and sustained in the Liberia to improve the health system and reduce mortality rate through evidence based planning and interventions for malaria.

Government health systems and structure

In resolving the challenges around HMIS utilization for decision-making and strengthening the information system, it is recommended that DHIS2 and HMIS tools specific training and mentoring be done on a decentralized phases and structured according to job specifications and roles. The findings showed that only the top hierarchy of malaria and health facilities understands the HMIS structure and processes. Even though 85% of the health staff or personnel understand the existence of HMIS and data collection, not all agree that decisions are made from the data collected to plan malaria interventions due to lack of staff and staffing capacities. Hence, it is also recommended that health staff and staffing should be chosen based on key roles, value and essential training to identify primary data personnel of HMIS at healthcare facilities. As recommended by LHPS from 2018 to 2023 and Esene regarding HMIS capacity, these focal individuals should consistently receive training and updates in training of trainers' sessions, enabling them to frequently disseminate this training at their healthcare facilities (Esene, 2015; LHPS, 2018 - 2023).

Improved supportive supervision should be more defined and provided to further strengthen the mentoring system as part of routing capacity building for staff, the study findings also indicated lack of funding for training or improved salaries for health staff that makes room for data errors due to late reporting and wrong attitudes towards the gathering and reporting of data at healthcare facilities. This training and proposed mentoring are recommended to further ensure correctness of information at health facilities on HMIS data gathered from malaria interventions by focal data officers. This process should engage all other health data clerks at the health facilities;

this process is agreed to benefit the quality of data and its use by essential health personnel engaged in data to form informed health choices (Esene, 2015). Another observation from the study was the demand for and usage of data by the health ministry and malaria program that was observed from the FGDs and KIIs; it was observed that data is mostly used when funding opportunities or when funders asked for it for accountability are not necessary for national planning and decision making. In its recommendations, this study would like to see a situation where data analysis will be a bottom-top approach and not a top-down one.

It is advised and recommended that HF should analyze health data collected from source at facilities. Even though data is transmitted upward, it will be very effective for planning if the health facilities also have a clear picture of malaria incidences to know what measures can be advised from the bottom. Just collecting and transmitting data to the central HMIS bank without understanding the trend at that level might affect the population before decisions are made from the central if at all, it is very helpful for health facilities at the local government and community level to assess and exhibit the same on the walls of their health facility and suitable feedback forwarded to the subsequent reporting level (Esene, 2015).

Analyzed data from this research study will further be engaged at facility during reviews and data verification spaces for improvement, and ways to improve on them will be deliberated and acted upon; the report of the meetings and collected data will then be transmitted through the DHIS2 platform and other necessary mediums to the central. This process will further help strengthen staff capacity and strengthen the information system for good decision-making and planning; in a bid to get things right it is recommended that HF should get more supportive supervision to avoid lapses in data collation and transfer. Re-orientation on data collection and collation using HMIS tools as an essential aspect of routine PHC activity will be very useful to the

health system. Also, recognition of personnels through incentives for consistent achievement at facilities could be encouraged in form of awards of excellence.

A Technical Working Group and members of the HMIS department of the MOH could champion this process for good decision-making and planning using data at the centre. However, it might not be 100% certain that this is not already done. Suppose this process is functional in the country's health system; in that case, the data flow and feedback mechanism to health facilities at the community, local government, and county levels should be strengthened for the health systems processes to be understood by all.

Collaborations and partnerships with private organizations (PPP)

The study observed from the findings that external donors and funders have contributed to strengthening the HMIS in Liberia, such as USAID, Clinton Foundation, WHO, etc. Therefore, it is recommended by this study in its recommendation that the ministry of health ought to work together more with funders and private sector to further expand and strengthen the country's HMIS structure and processes, including IT and some offline data entry due to power challenges. With donor support on HMIS strengthening that further improve data strength to increase policy formation for the country, as it was observed that power/electricity was among the discoveries from this research that disrupts data transmission from reporting areas and will persist in providing incomplete data. that hampers good planning. These organizations can also support some form of power and basic HMIS and internet infrastructures; this will further improve timely reporting and accurate data that strengthens quality data for planning.

This study with these findings will recommend a supportive political will to be achieved from the government's angle that understands data demand and use, especially for national health

planning is very essential; this could be a very important criterion to achieve many significant results relating to the HMIS data and malaria control/intervention decision-making. This proposed orientation by the government is advisable to change and adopt that power/electricity was among the discoveries from this research that disrupts data transmission from reporting areas and will persist in providing incomplete data (Esene, 2015).

Health workers and data officers

The Community Health Workers and medical officers, including heads of units at the facilities, should be given targeted and structured reorientation on HMIS and training that will help emphasize goals and objectives of information retrieved from HMIS for usage and disease implementation. This approach will support health workers and data entry officers, including central DHIS2 units' staff to re-orientate their capabilities on data use. Further, by adopting a more pragmatic approach that changes narratives on data collection and use through adjusting staff attitude and introducing a more target-driven attitude at health service points based on intervention feedback garnered from service provisions data.

Health professionals and data specialists managing data should be motivated to participate in self-development educational programs that will enhance their service delivery skills, such as brief courses on data demand and utilization and statistics that will augment their capacity to summarize and analyze health data using statistical techniques and develop/improve their abilities to conduct additional surveys for information (Esene, 2015; Lippeveld et al, 1997). Thus, capacity building through training and refresher courses could greatly inspire the health personnel to generate quality data with refreshed and advanced knowledge of the HMIS (Esene, 2015; Lippeveld et al, 1997).

These can be accomplished by arranging brief consultative and technical courses that will enhance not only the data skills but also their management and leadership skills (Esene, 2015; Lippeveld et al, 1997). Further, mediums that help data officers access health information in the form of small in-house libraries (such as HMIS manuals and IT publications or data manuscripts) or e-libraries via the provision of reliable IT infrastructure will improve self-improvement that generates quality data (Esene, 2015; Lippeveld et al, 1997).

It is agreed from reviews that scheduled practical training sessions help support health workers, especially if it's rotational practice and on regular basis, during which health workers can gain and update their knowledge (Esene, 2015; Lippeveld et al, 1997). This sort of practical training is recommended for the country's health systems through health facilities engaging a down top approach that involves all level of data personnels that includes junior and senior staffing, data demand and use of information for further planning and decision-making becomes highly obtainable. Applying information encourages evidence-based healthcare and serves as motivation by itself; it has been noted that once healthcare workers begin to incorporate information into management choices, the quality of data ultimately enhances (Esene, 2015; Lippeveld et al, 1997).

Recommendations for future research

Introduction

Based on study findings, there were some further research gaps identified that, if given priorities, they will contribute to improving the HIS and further strengthen the capacity of the HMIS and DHIS2 utilization in health facilities across countries and especially on malaria control interventions.

Further, the result from this study and its recommendation for future research is expected to provide a body of knowledge to strengthen health management information systems and evidence-based decision-making using data.

Impactful progress has been made in Liberia HMIS structure and processes, as described in the implication section of Chapter 5. Still, some important research questions and technical support needs remain (especially regarding IT, Power, data use and capacity). The research recommendations are organized in this chapter according to the three key study findings that relate to (1) Data analysis and use at the HFs and districts levels for down to top information and planning Capacity on data demand and use, (2) other electronic medical records in health management Information Systems and (3) National health information systems financing.

This study in its findings showed that mutuality, interface and integration of data now existing between all levels of healthcare facilities and data collection points could help to support facilitation and enhance the familiarity, training and data used by health workers through supportive and guided processes form the data collection sites (community rural facilities to the urban health facilities) especially linkages between the interventions frameworks and program planning through HFs. These interactions between the levels of health care data answer the

research hypothesis H1: “That the health management information system has been pictured and used correctly”.

1. Capacity for data demand and use

The study results showed that the managers and leaders should decide to undertake a health information system assessment for entire health services or programs supported by MOH and other funder agencies, this will in turn strengthen health care and data systems. Embarking on such a process in the health systems structure could inspire program leaders’ performance on data and actions that improve health data performance for interventions. This would also improve sound data use and assurance that build confidence to use analysis findings to make appropriate and correct decisions for planning within health care providers (malaria) and national disease intervention programs. These decisions should be based on commitment to improving date demand systems that include quality of data, its properness and timeliness, and use for informed decision-making for health systems, particularly at the service delivery levels in managing health interventions (Malaria disease) and community health (Lippeveld et al, 2000).

The Liberia HMIS and data process is typical in various sub-Saharan African nations, where intricate national health surveillance systems necessitate political determination, substantial financial backing, and an inspired workforce within the health sector, as outlined in Chapter 5 (implications) (Gething, 2006). In numerous developing or low-income nations, the health ministries may face choices between purchasing medications and producing HMIS forms similar to the donor agencies will advise for counterpart funding (Gething, 2006). The quality of Liberia's HMIS and data use for informed decision efforts lies in some clear challenges encountered that includes underfunding experienced by the government health sector, as recorded from the findings that donors and funders engineer data analysis and use (DQIP, 2022). Hence, it is advised for the

Liberia MOH on the to upgrade HMIS disease capture across all HFs covering all diseases to enable accurate, timely and reliable data crucial to organizing and overseeing health service delivery for disease-specific priorities (Gething, 2006). However, it is argued and believed that incomplete data into the HMIS for organizing either national or sub-national intervention could significantly cause a program redirection due to using inappropriate data for planning resulting in national program disaster (Gething, 2006).

The recommended development and outcomes outlined in this research bring forth numerous significant inquiries that need additional focus to be explored. This study additionally examined the existing delay time during which data is being produced (patients receiving treatment at facilities), when data is inputted into HMIS and period for data availability for analysis is approximately four weeks (Gething, 2006). To avoid incomplete data and enhance timely data, possible future research will explore "integrating the nationwide HMIS data with data from a much smaller number of sentinel facilities and its effect in data use" as discussed by (Peter, 2006). (Peter, 2006), further stated that when systems are established to gather dependable data on a monthly basis and to utilize this current data to guide the forecast from the complete dataset (Gething, 2006). A focus on second research will focus on the question, "How many sentinel facility locations would be required to accomplish this goal with a satisfactory degree of precision, and how their site selections could be made to enhance their effectiveness?". A key research focus for the future is to examine "the use of statistical capacity building and its effect on health system data analysis, use and planning". Building staff capacity with some statistical packages has been identified as an important need for staff knowledge by some health staff, for example, the World Bank STATCAP initiative that was designed to address data analysis to strengthen data systems for countries (World Bank, 2005). Again, findings from this study showed that the necessity to

develop skills for health data analysis and information construction is frequently neglected within the health sector and thereby being short staffed. This lack of staff with analytical backgrounds has affected the data quality, as recorded from this research findings in some districts. To this end, it becomes paramount that the country's health system will need health data staffing with some form of numeric and statistical skills in other understand analyzed data from generated. FGDs' findings showed that this part of data expertise is rarely mentioned in human resource requirements, this occurs because of the assumption that from understanding or staying long in healthcare programs the employees are able to assume the roles of health information officers and data clerks whenever they are requested.

Another review in its position claimed that some recent health policy and practices by countries have tried to address capacity shortfall (Gething, 2006). Considering health sector reform generally as it regards data and health systems, it is advised that decentralization of capacity building could produce an effective result if well attended to and then resource allocation could be well distributed and utilized correctly. On the other hand, capacity on tools usage, especially HMIS for the generation and analysis of information at the PHCs level have been adequately advanced but could be better if data analysis at a very simple level can also be introduced (Gething, 2006). However, as at present data analysis and expertise is primarily concentrated or centralize in Liberia's MOH at the capital.

More health facility care personnel, clinical staff, and data entry clerks should receive training in HMIS to guarantee precise data collection and prompt reporting (Kasambara, 2016). It is recommended that forms and registers should consistently be accessible at the workspace of the facility in charge, coordinators and medical staff to prevent data inconsistencies and enhance timely reporting (Kasambara, 2016). The existing forms require examination and revision to tackle

issues related to indicators for emerging and significant diseases of interventions, as noted in the previous literature examined (Kasambara, 2016). Given the gaps in human resources, it is essential that the Ministry of Health hires additional HMIS officers within its workforce who possess the necessary degrees as mentioned in the job qualification criteria. as it appears to be paramount around Africa (Kasambara, 2016). This study will recommend further research to “investigate consistency of HMIS data analysis and use for planning at the lower PHCs/HFS level” by districts and community health facility coordinators or managers.

2. Other electronic medical records in health management information systems

What is evident from the papers published in recent years is that the issues affecting health information management are broad and standard internationally (Winter, 2017).

From the study findings, HMIS will require some form of institutional and enlightening support factors to cultivate suitable attitudes that enhance clear information and data use in the system. Again, the current study and this study's findings showed limited research on predicting the future of health via information technology and data.

Data and Information Technology can be viewed as one of the most promising fields of technological advancement in healthcare, though this study focused on HMIS use for policy decisions and making good interventions decisions. As a result, this study found some gaps while evaluating the application of IT to enhance data management in health. This is why substantial investments have been made in developed countries worldwide.

Health Information Technology foresight may be applied to recognize, choose, and exhibit scenarios for an extended future in health care via planning; the gap was evident during this study as most of the data staff are short of information technology and data analysis skills. Suppose further research on health and information technology is engaged. In that case, other electronic

medical recording systems will be identified, and the reliance on only HMIS and DHIS2 will be reduced in developing countries. The findings of these studies can serve as a foundation for decision making and policy formulation in the health data collection as regards other medical records, particularly at a national level. Moreover, the involvement of Experts and policymakers may assist in establishing more realistic anticipations regarding the future of information technology. and improved medical records in a long-term perspective (Winter, 2017).

Research into other forms of Electronic Medical Records (EMRs) from Information Technology and HMIS will offer some very important supports to national healthcare, such as digital health records that could enable economical access to more comprehensive and precise health information that funders and stakeholders can utilize to make intervention choices regarding patient treatment at facilities level. Data dissemination and communication was also assessed amongst healthcare providers who were research participants, it was claimed by the participants that quarterly meetings and some form of communications networks can facilitate the exchange of information being spread among health facilities and decision makers that include funders and donors. It was also expressed by participants that engaging electronic data processing techniques can support healthcare staff for quick and proper data use, assist health services researchers, as well as public and private entities, in performing more advanced analyses of health care usage and execution. Just as recommended in this chapter earlier, healthcare and services have to adopt a range of technical and organizational practices to protect health information, and the health units and departments in the country will have to work with the government to create a legal framework and a proper set of incentives for heightening interest in data and analysis from the facility levels. Although some recommendations are explicitly directed to electronic health information in Health

Management Information Systems, they are equally applicable to electronic medical records aside from paper based.

As the field work conducted for this study has observed, the shift to integrated and informed health delivery systems has managed to create a growing demand for electronic medical records due to data stability and data links capable of transferring data within and across organizations with the use of DHIS2 platform. Electronic medical records and HMIS enable HFs to more effectively analyze data for the purpose of interventions and enhancing care for the population, overseeing the quality of care, examining the use of health care resources, and making critical decisions for programs. Certain participants have stated that the accessibility of health information online contributes to improving the quality of health care delivery as outlined by the National Academies of Sciences, as well as efficiency of the derived information (Winter, 2017; NAS, 1997). Implementers will recognize the benefits of combining and exchanging data among HFs by utilizing a more cohesive service delivery system and data capture using HMIOS. Future research on "application of information technology to HMIS and health care using electronic medical records" this will further investigate and recommend on advantages of data collection and utilization (Winter, 2017).

Financing – National funding to the health management system

This research examined its results on how resources, capacity, and responsibility respond to the data supply aspect of the HMIS. Data utilization that tackles inquiries such as who requires the data and for what purposes do they need it? A clear response is that health policymakers require data to inform their decisions (Esene, 2015). A regrettable aspect of healthcare systems in numerous regions worldwide is that choices are made even when the information is not trustworthy, which has been the case in developing countries (Esene, 2015). In Africa, it tends to

tilt towards the understanding that health decisions are often made based on political speculation when data is not involved or if the health information is not efficient and this includes convenience or donor demand. Therefore, this kind of process might lead to an assumption that if data is not correctly used, this might lead to inefficient and ineffective use of resources because it needs more accurate decisions from complete and correct data for planning.

Further, it was observed that it isn't because poor nations are unable to invest in effective health information systems, primarily due to their lack of knowledge. of its effectiveness to health system and knowing fully well, they cannot afford to be without it (Carla AbouZahr et al, 2005). In African countries, it is the appropriate moment for serious effort and resources to be directed toward developing HIS that can successfully assist public health. WHO report (2018). Therefore, further research on co-financing the national health management information systems (HMIS) will expose some critical parts of the health systems regarding ownership and political will.

The study observed from the findings that external donors and funders have contributed to strengthening the HMIS in Liberia, such as USAID, Clinton Foundation, WHO, etc. Therefore, it is advised that the Ministry of Health should continue to collaborate more with private public partnerships (PPP) to improve the HMIS systems and infrastructures, including IT and some offline data entry due to power challenges. Funders and private partners will tend to help redirect data expectation through their supports, these supports could be power/electricity which was one of the findings from the study as stated earlier that interrupts data transmission from report areas and will continue to present incomplete data that hampers good planning. These organizations can also donate some sources of power, HMIS tools and training, equipment, and IT stationery, this will further improve timely reporting and accurate data that strengthens quality data for planning. It is expected that the country will finance such challenges. Still, unfortunately, from the study

findings, they are left with no support from the government and enabling the generation of incomplete data from health facilities.

Conclusions

A systemic approach is implied in the design of an information system that is both efficient and effective, hence this study of HMIS and use focused on the key heal care structure and system parameter of data use and planning. The global consideration of the needs of stakeholders at all levels of decision-making, including the level of the healthcare system, is taken into consideration by this systemic approach. However, because it is carried out in a consensual manner without an enforceable data use framework with coordination, it has not been implemented sufficiently in practice. Nevertheless, it has been noted that the majority of initiatives launched in Africa to establish or enhance HMIS have integrated this systemic approach by considering the requirements of various players. The primary worry would be that this systemic method is frequently unsupported by strong leadership or governance from the agency in charge of the health space. However, some nations have succeeded in gathering high-quality health data throughout the course of initiatives with stakeholder consensus. This gives rise to optimism that improved health outcomes may be attained with a coherent and cohesive state health data management system.

The results, though, revealed a few significant areas that need to be addressed, notably at the primary health facility level, which acts as the data entry point for national planning, decisions, and interventions. In the Primary Health Care facilities, some of the healthcare workers studied had limited understanding of the National Health Management Information System, and around 35% had a strong grasp of the data quality practice standard. The majority of the healthcare staff displayed a positive outlook, but less than 10% of them had a negative outlook.

In addition, some of the health personnel who worked with health data showed some low quality practices for the National Health Management Information System, while between 35 and 40 percent had good data handling practices. The type of data collected, validated, and transmitted from the community to the central data system with quality and without transcription errors, as well as a thorough understanding of program level data, were the primary factors determining proper use and application of the National Health Management Information System at healthcare facilities.

A few of the health facilities engaged were capable of operating the National Health Management Information System activities, none of the health facilities had internet connectivity and budget specific for HMIS, most HFs do not have power or stand by generating set and about 95 percent of the HFs had focal persons handling data, where there was no data clerk it was handled by the officer in charge.

In terms of the entire data accuracy, institutional malaria data had significant data quality problems while death rate data had some significant data quality issues.

In its design, this study has explored the theoretical reasoning behind using the Health Information System (HIS), its importance to health interventions/control and how it relates to functional health systems using the Liberia Malaria interventions (as a case study for developing countries). The research results drew its fundamental understanding and findings of health data management and its systems in Liberia health system from a desk review of existing documents and articles globally with a key focus on Africa; and examined relationships between HMIS, decision-making and planning in developing countries such as the Liberia malaria programme. Significantly, how it impacts the capability of health management information system to produce

high-quality program data that determines intervention, malaria control, transformation and performance from key data outcomes and results Focusing on data use (MEASURE, 2019).

Though not much research has been done on the use of HMIS and the health sector in Africa recently, most of the health information research has been based on IT and health data management but not a product of data use as demonstrated in this study. This study has purposely mirrored its literature on the most recent literature on health data demand and use and a few older literatures focusing specifically on HIS.

The commonly used phrase "health management information system" can be misleading because it might imply that there are separate information systems for each function (WHO, 2015; Lippeveld et al, 2018)

Health information systems integrate data collection, processing, reporting, and use of the information needed to enhance health service effectiveness and efficiency through better decision-making. management throughout the continuum of healthcare services (WHO, 2015; Lippeveld et al, 2018).

As also demonstrated by (Mboera et al, 2021), that poor data utilization was common in their research hence most health facilities and health systems are still fighting to combat the challenges in achieving quality data. This study also identified data management skills as one of the very key challenges amongst staffs handling data in health facilities, in addition to inadequate supervision and feedback from the regional or national levels to the community health systems as the case may be for data ownership and this includes inadequate resources. Inadequate capacity building has been sounded most frequently by so many researchers including (Mboera et al, 2021), were factors related to the routine performance of the HMIS in health structure still need some form of understanding. The study, therefore, continues to recommend a need for every country to

have adequate and trained staff with key HMIS tasks and have clear governmental structures for the system that are well understood by all the health workers. In addition, there is a need to continue in the conduct of periodic support supervision as already indicated earlier for HMIS activities across all HFs and sites of interventions. Again, as a reminder, this calls for innovative ways to motivate staff to perform HMIS related tasks and use evidence from routine and quality health data to make evidence program-based decisions.

Additionally, the study's findings demonstrate that, despite being regularly gathered by the same data actors, HMIS data are underutilized at both the district and facility levels. Limited human resources, a shortage of SOPs, inadequate supervision, and insufficient training are among the main difficulties. Numerous issues affected the consistent operation of districts and the health management information system for facilities, including insufficient resources, sub-par capacity development, insufficient oversight and feedback, and insufficient data management skills, all of which cannot be overstated.

As a result, this research found that the system doesn’t really demonstrate or have an adequate open governance structure that is shared with all healthcare professionals and that there should be enough workers who have been trained in HMIS responsibilities. It is also crucial to base decisions on routine health data, use innovative strategies to motivate workers to carry out HMIS-related tasks, and conduct ongoing support supervision for HMIS operations. To improve the use of HMIS for evidence-based decision-making, the study sees frequent mentoring, performance monitoring using standard tools, and reinforcing feedback loops as having a few gaps.

The suggested approach to restructuring health information systems will help system designers in poor nations address the shortcomings of current routine health information systems in at least three (3) ways (WHO, 2015; Lippeveld et al, 2018)

First, it responds to the data demands of health services at various strategic planning and operational levels, with special attention paid to of treatment providers (Lippeveld et al, 2018). Care providers will be encouraged to raise the standard of care if the information system offers data that is immediately helpful for managing patients, clients, and health units and the information gathered for transmission to higher authorities (Lippeveld et al, 2018). Secondly, it allows for the creation of a health information system that supports the entire health services system rather than disparate systems (Lippeveld et al, 2018). It demonstrates backing for distinct disease-focused approaches, vertical initiatives and intervention focused results (Lippeveld et al, 2018).

An information system of this kind is far more capable of guaranteeing a seamless, two-way exchange of information between the various tiers of healthcare services such as patient referral and counter-referral systems, supervisory systems, management support systems like medicine and supply distribution systems, are all built on this information exchange and the arrangement of vital public health services, like disease monitoring (WHO, 2015; Lippeveld et al, 2018).

Lastly, and most importantly, as a result of the enhanced health information system management structure and data process, there will be more relevant and higher-quality data available. that is also more likely to be used in the decision-making process at all levels and for all management functions of the health system (WHO, 2015; Lippeveld et al, 2018).

As noted in chapter 2, the match of the information is facilitated by using health information system development as a method to enhance the overall management environment system, which is even more crucial with the current or future health care services system (SDG, 2015; Koumamba et al, 2021). For instance, in Pakistan, integrating a population-based indicator like maternal mortality into the newly reorganized health management information system for

primary care facilities (Koumamba et al, 2021). That has encouraged the health unit employees to engage more actively in the community, which is a strategy that is actively supported by the national and provincial administrations (Lippeveld et al, 2018; Koumamba et al, 2021).

Alternatively, the effort to integrate into the health services, a policy that was strengthened by the development of a thorough monthly activity report that combined previously separate report forms was a component of the national health plan (Lippeveld et al, 2018). In addition, a well-functioning intersectoral health information system that is based on a decentralized district health system and includes the community's active involvement can be the beginning of the slow creation of an intersectoral health information system, as suggested by the (WHO, 2015; (Lippeveld et al, 2018; Koumamba et al, 2021).

The findings of this study have demonstrated that certain developed nations possess highly advanced health data and information systems that direct decisions to inform the planning and delivery of health services (Lippeveld et al, 2018; Koumamba et al, 2021). It also clarified that many less developed countries have not established practical and functional health information systems (Lippeveld et al, 2018; Koumamba et al, 2021). Therefore, planning and execution of health programs in underdeveloped or developing nations such as Africa. are conducted with sufficient information about the population due to the consistency of data collection and analysis from facilities and groups using the services (Koumamba et al, 2021). Hence, from findings, program planning and implementation are primarily based on inaccurate information or inadequate data gathering that is incomplete, especially from the urban health facilities that cover about 65% of cases (MEASURE. 2019).

According to the study, this condition has frequently resulted in inefficiency, inequality, and waste in delivering health care services and difficulties in comprehensive reporting (Yaser et al, 2019; MEASURE, 2019).

The FGD responses noted that and as described by the heads of health facilities as it relates to the research was that “there remains an extensive journey ahead in realizing the goals of utilizing data for decision making”. This relates to the research question on how reliable and appropriate the malaria HMIS data for disease control has helped decision-making, also most of the data managers mentioned that “there has been a remarkable achievement in data collection, but the objective of data usage has only been achieved at an estimated 50%”. This 50%, according to the findings, is skewed towards the donor-funded organizations that must submit data and progress for planning.

The study shows that the application of well-organized and effective health information and its management system, is dependent on the health structure and data flow systems. This implies that in health management information system design and its systemic approach, depends on a couple of important factors such as systems strengthening and availability major infrastructures like internet connectivity and computer systems play key roles in data demand and use. This methodical strategy for HMIS takes a holistic perspective of the demands of stakeholders at every level of decision-making, including the healthcare system's planning and policy creation. In such a case, IT solutions like DHIS alone are insufficient. It mandates that the creation of any HIS be preceded by thoughtful upstream consideration of how to improve its governance by establishing and putting forth a clear conceptual framework. The latter will allow for the analysis and direction of the creation and integration of IT solutions into the HIS.

However, the HMIS platform in Liberia have been over 14 years, some data quality issues that includes accuracy, adequacy, timeliness and completeness of data still exist and making some data policies not sufficiently implemented in practice (DQIP, 2022). This is because implementation is not properly monitored through an enforceable supportive supervision arm as recorded in the national developed framework for coordination (national strategic plans), this study also observed that most projects being implemented in Liberia by donors and funders such as USAID has set up or improve health information systems and integrated this comprehensive approach by taking into account the requirements of different participants as stated by (DQIP, 2022 – 2027).

From the study findings, the core concern would have been that this universal approach of the HMIS is frequently not backed by robust leadership from departments or units at MOH responsible for healthcare. However, the Liberia health information system have been able to scale a huge part of this challenge by having a coordination HMIS unit at the MOH.

Nevertheless, during the time of project implementation by funders and donors, a consensus between stakeholders and funders to support the data system have aided Liberia to have managed to obtain quality health data for donor interventions planning and some framework development such as the data quality implementation plan (DQIP, 2022 – 2027). This conveys a viewpoint with expected confidence that through the enhancement of the recorded health information system and ongoing cohesive and unified governance participation regarding the oversight of the national health information system, improved health indicators can be attained (DQIP, 2022 – 2027; Lippeveld et al, 2018; Koumamba et al, 2021). Lastly, in this case, the findings have shown that IT solutions such as DHIS2 alone are not enough to achieve the said national data use objectives. It then requires that during the development of any HIS or in addition

to the HMIS system, severe leadership reflections on enhancing its governance support system ought to be executed by outlining and suggesting a cohesive and comprehensive conceptual framework (DQIP, 2022 – 2027; Lippeveld et al, 2018; Koumamba et al, 2021). This will enable the assessment and direction of the evolution and incorporation of unified IT solutions into the HMIS. that supports both online and offline data use and retrieval (Lippeveld et al, 2018; Koumamba et al, 2021).

These findings also drew an extensive reference from the fact that most of the studied health personnel in the PHCs facilities needed better knowledge of the national health management system, and slightly above five per cent had good knowledge as same with other African countries (Esene, 2015), This study considered that most health facilities are rural (65%). However, most districts and community health officers had constructive attitudes towards HMIS and just a little lower than 10 percent had undesirable attitudes or understanding toward the HMIS and data gathering that could be due to poor understanding of the process.

Most health personnel handling health data at rural health facilities needed better practice of national HIMS practice, and only about 45% had good practice. This becomes a highly important factor in effective practice and use of the national HMIS at healthcare facilities (Esene, 2015). This is important because it will further strengthen data flow from communities and improve practices of NHMIS processes respectively, another problematic situation has to do with the power source and systems to transmit data if captured on a paper-based system.

Out of the 45 health facilities/health centres surveyed, all the facilities could operate the National Health Management Information System activities. These findings were in line with answering the question, “How has the health management information system developed and evolved in the past five years” that shows how the data and information system has evolved the

national information system in Liberia for the past years, from an excel data collection and collation system with no transmission to a data transmission system using the HMIS plans called the DHIS2.

Although every health facility in the urban area had access to the Internet and funding specific for the HMIS as found in other less data developed African countries like Nigeria, like 70% of HFs had a stand-by generating set (Esene, 2015). About 95% of the health facilities surveyed had designated individuals managing data at facilities.

Concerning the overall accuracy of the data, malaria data experienced minor data quality problems at the urban health centers, but most challenges are majorly from the rural health facilities. These facilities are challenged with electricity and other power sources, including systems to enter data.

From the findings, it is therefore paramount that strengthening health data systems from health facilities is critical to establishing a more consistent and sustainable health system. Hence, this is why the Liberia health information system study result is expected to support the country's health system to provide critical outcomes on the quality of data that supports the governments to respond to health needs promptly with data informed decisions. Especially in public health crises, an example is the Ebola outbreak in Liberia and the latest challenges posed by COVID-19.

Healthcare services worldwide are meant to be delicate services provided to citizens by their governments through structured health facilities. Therefore, with the limited resources in developing countries such as Liberia, essential decisions likely to have the most significant impact on individual health should be made (WMR, 2023). Therefore, the research has demonstrated that inadequate healthcare service delivery may lead to loss and damage to lives. Consequently, the aim of any healthcare facility is to offer quality services to its community, as described in the

literature (Lippeveld et al, 2018; Koumamba et al, 2021). However, the biggest challenge remains comprehending data needs and utilization in Liberia's Health Information Management Systems that obstruct planning and objectives of attaining quality services. Therefore, this is the reason why the study utilized a duality of structure and information used to recommend quality outcomes for planning.

This study's result and findings are expected to provide a body of knowledge on why health management information systems and evidence-based decision-making remain weak and how they can be strengthened sustainably in developing countries (Liberia) to improve health systems and reduce mortality rates through evidence-based planning and interventions.

The study supports the idea that Human development has been one of the most discussed challenge information and lack of information systems in its findings; efforts are being made globally to correct this challenge, especially by the United Nations (UN) agencies (UN-SDG, 2015) and donor agencies like PEPFAR CHAI in Liberia.

In Africa, HIS is observed to be an enormous challenge that makes decision-making and planning in the health sector very difficult, especially in combating diseases like Malaria or curtailing the burden. (WHO, 2010, 2017; Koumamba et al, 2021). For this burden to be reduced, a critical decision on planning, allocation of resources, policies for controlling diseases, capacity building for staff and orientation considering the limited resources should be highly engaged.

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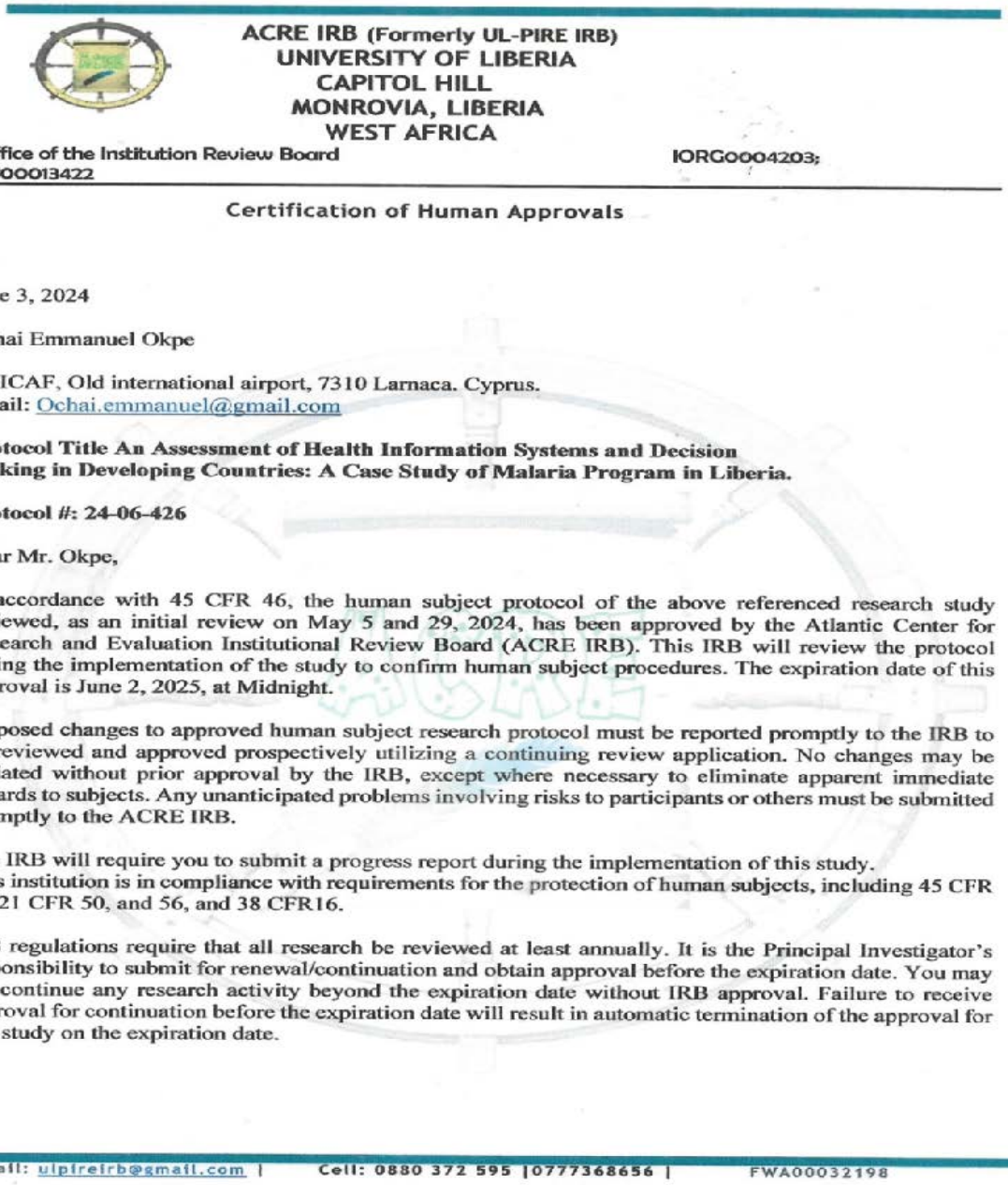
APPENDICES

Appendix A:

APPROVALS AND CONSENTS

1. ETHICS COMMITTEE APPROVALS



ACRE IRB (Formerly UL-PIRE IRB)
UNIVERSITY OF LIBERIA
CAPITOL HILL
MONROVIA, LIBERIA
WEST AFRICA

Office of the Institution Review Board IORG0004203;
IRB00013422

Certification of Human Approvals

June 3, 2024

Ochai Emmanuel Okpe

UNICAF, Old international airport, 7310 Larnaca. Cyprus.
Email: Ochai.emmanuel@gmail.com

Protocol Title An Assessment of Health Information Systems and Decision Making in Developing Countries: A Case Study of Malaria Program in Liberia.

Protocol #: 24-06-426

Dear Mr. Okpe,

In accordance with 45 CFR 46, the human subject protocol of the above referenced research study reviewed, as an initial review on May 5 and 29, 2024, has been approved by the Atlantic Center for Research and Evaluation Institutional Review Board (ACRE IRB). This IRB will review the protocol during the implementation of the study to confirm human subject procedures. The expiration date of this approval is June 2, 2025, at Midnight.

Proposed changes to approved human subject research protocol must be reported promptly to the IRB to be reviewed and approved prospectively utilizing a continuing review application. No changes may be initiated without prior approval by the IRB, except where necessary to eliminate apparent immediate hazards to subjects. Any unanticipated problems involving risks to participants or others must be submitted promptly to the ACRE IRB.

The IRB will require you to submit a progress report during the implementation of this study.
This institution is in compliance with requirements for the protection of human subjects, including 45 CFR 46, 21 CFR 50, and 56, and 38 CFR16.

IRB regulations require that all research be reviewed at least annually. It is the Principal Investigator's responsibility to submit for renewal/continuation and obtain approval before the expiration date. You may not continue any research activity beyond the expiration date without IRB approval. Failure to receive approval for continuation before the expiration date will result in automatic termination of the approval for this study on the expiration date.

E-mail: ulpireirb@gmail.com | Cell: 0880 372 595 |0777368656 | FWA00032198

ACRE IRB (Formerly UL-PIRE IRB)
UNIVERSITY OF LIBERIA
CAPITOL HILL
MONROVIA, LIBERIA
WEST AFRICA

Office of the Institution Review Board IORG0004203;
IRB00013422

Certification of Human Approvals

Kind regards.

Sincerely yours,

ATLANTIC CENTER FOR RESEARCH & EVALUATION
INSTITUTION REVIEW BOARD (IRB)

Prof. Edward G. Smith, MPhil
Chairperson, ACRE-IRB

IRB Review Dates: 05/05 & 29/2024
Approval Period: 06/03/2024 through 06/2/2025
Review Type: INITIAL
IRB Review Action: APPROVED
Assurance # FWA00032198

E-mail: ulpireirb@gmail.com | Cell: 0880 372 595 | 0777368656 | FWA00032198

2. GUARDIAN INFORMED CONSENT

UU_GIC - Version 2.1

Guardian Informed Consent Form

Part 1: Debriefing of Participants

Student's Name: Ochai Emmanuel Okpe

Student's E-mail Address: ochai.emmanuel@gmail.com

Student ID #: R1807D5599078

Supervisor's Name: Dr Charoula Konstantia Nikolaou

University Campus: Unicaf University Zambia (UUZ)

Program of Study: UUZ: PhD Doctorate of Philosophy

Research Project Title: Understanding Health Information Systems and Decision-Making for Health: Case study using malaria data in Liberia

Date: 28-Jul-2022

Provide a short description (purpose, aim and significance) of the research project, and explain why and how you have chosen this person to participate in this research (maximum 150 words).

Purpose
To develop an understanding of the evolution and functionality of the health information system and its role in decision-making related to health planning, especially malaria prevention and control in Liberia.
Aims
This study aims to examine the causes deterring the ability of the health management information system form generating high quality malaria related data and decision making in the programming and intervention, with recommendations to strengthening the national health information systems through staff capacity.

The above named Student is committed in ensuring participant's voluntarily participation in the research project and guaranteeing there are no potential risks and/or harms to the participants.

Participants have the right to withdraw at any stage (prior or post the completion) of the research without any consequences and without providing any explanation. In these cases, data collected will be deleted.

All data and information collected will be coded and will not be accessible to anyone outside this research. Data described and included in dissemination activities will only refer to coded information ensuring beyond the bounds of possibility participant identification.

I, Ochai Emmanuel Okpe **, ensure that all information stated above is true and that all conditions have been met.**

Student's Signature:

UNICAF UNIVERSITY

UU_GIC - Version 2.1

Guardian Informed Consent Form

Part 2: Certificate of Consent

This section is mandatory and should to be signed by the participant's legal guardian

Student's Name: Ochai Emmanuel Okpe

Student's E-mail Address: ochai.emmanuel@gmail.com

Student ID #: R1807D5599078

Supervisor's Name: Dr Charoula Konstantia Nikolaou

University Campus: Unicaf University Zambia (UUZ)

Program of Study: UUZ: PhD Doctorate of Philosophy

Research Project Title: Understanding Health Information Systems and Decision-Making for Health: Case study using malaria data in Liberia

I have read the foregoing information about this study, or it has been read to me. I have had the opportunity to ask questions and discuss about it. I have received satisfactory answers to all my questions and I have received enough information about this study. I understand that the participant is free to withdraw from this study at any time without giving a reason for withdrawing and without negative consequences. I consent to the use of multimedia (e.g. audio recordings, video recordings) for the purposes of the participation to this study. I understand that all data will remain anonymous and confidential, unless stated otherwise.

I, Bennard Ochayi, the legal guardian of Ochai Emmanuel Okpe allow and provide consent that Ochai Emmanuel Okpe can willingly participate in the study.

I, Bennard Ochayi, the legal guardian of Ochai Emmanuel Okpe have been ensured that verbal consent given by Ochai Emmanuel Okpe will also be taken before the study.

3. GATEKEEPER LETTER

UNICAF UNIVERSITY

UU_GL - Version 2.0

Gatekeeper letter

Address: The Liberia Ministry of Health, montsera

Date: 28-Jul-2022

Subject: Request for support on doctorate study

Dear Sir/Ma,

I am an/a doctoral student at Unicaf University Zambia.

As part of my degree I am carrying out a study on [Understanding Health Information Systems and Decision-Making for Health: Case study using malaria data in Liberia].

I am writing to enquire if you would be interested in/willing to allow participation of your ministry (Health) and departments in this research.

Subject to approval by Unicaf Research Ethics Committee (UREC) this study will use a mixed research methods (quantitative and qualitative) to gather health facilities data through the DHIS2 (HMIS) historical data and potential participants that will either be data/ M&E officers or record staff of health facilities in Liberia to be interviewed.

[The title of the research is on understanding Health Information Systems and Decision-Making for Health: Case study using malaria data in Liberia, The research will focus mainly on the WHO (2000) verdict that identified the health management information system (HMIS) in Africa as a huge challenge, which now makes decision-making and planning in the health sector very difficult to attain, especially in combating malaria in Africa. The project is supervised by Dr Charoula Konstantia Nikola]

[I wish to request your support to the study by allowing access to malaria patient data through the DHIS2 database (just patient data), select HFs and participants. Also, the qualitative data for analysis to be obtained through KII with health facility staff involved in data entry and database officers with their consent. The estimated time for each interview or data collection process will be approximately 1 to 2 hours.]

Thank you in advance for your time and for your consideration of this project. Kindly please let me know if you require any further information or need any further clarifications.

Yours Sincerely,

Ochai Emmanuel Okpe

Student's Name: Ochai Emmanuel Okpe
Student's E-mail: ochai.emmanuel@gmail.com
Student's Address and Telephone: +2348036730505
Supervisor's Title and Name: Dr Charoula Konstantia Nikolaou
Supervisor's Position: Instructor
Supervisor's E-mail: c.nikolaou@unicaf.org

4. INFORMED CONSENT

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UU_IC - Version 2.1

Informed Consent Form

Part 1: Debriefing of Participants

Student's Name: Ochai Emmanuel Okpe

Student's E-mail Address: ochai.emmanuel@gmail

Student ID #: R1807D5599078

Supervisor's Name: Dr Charoula Konstantia Nikolaou

University Campus: Unicaf University Zambia (UUZ)

Program of Study: UUZ: PhD Doctorate of Philosophy

Research Project Title: Understanding Health Information Systems and Decision-Making for Health: Case study using malaria data in Liberia

Date: 28-Jul-2022

Provide a short description (purpose, aim and significance) of the research project, and explain why and how you have chosen this person to participate in this research (maximum 150 words).

Purpose
To develop an understanding of the evolution and functionality of the health information system and its role in decision-making related to health planning, especially malaria prevention and control in Liberia.
Aims
This study aims to examine the causes deterring the ability of the health management information system form generating high quality malaria related data and decision making in the programming and intervention, with recommendations to strengthening the national health information systems through staff capacity.

Potential significance
This research result will be presented to decision makers and used to explore or recommend how e

The above named Student is committed in ensuring participant's voluntarily participation in the research project and guaranteeing there are no potential risks and/or harms to the participants.

Participants have the right to withdraw at any stage (prior or post the completion) of the research without any consequences and without providing any explanation. In these cases, data collected will be deleted.

All data and information collected will be coded and will not be accessible to anyone outside this research. Data described and included in dissemination activities will only refer to coded information ensuring beyond the bounds of possibility participant identification.

I, Ochai Emmanuel Okpe, **ensure that all information stated above is true and that all conditions have been met.**

Student's Signature: 

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Informed Consent Form

Part 2: Certificate of Consent

This section is mandatory and should to be signed by the participant(s)

Student's Name: Ochai Emmanuel Okpe

Student's E-mail Address: ochai.emmanuel@gmail

Student ID #: R1807D5599078

Supervisor's Name: Dr Charoula Konstantia Nikolaou

University Campus: Unicaf University Zambia (UUZ)

Program of Study: UUZ: PhD Doctorate of Philosophy

Research Project Title: Understanding Health Information Systems and Decision-Making for Health: Case study using malaria data in Liberia

I have read the foregoing information about this study, or it has been read to me. I have had the opportunity to ask questions and discuss about it. I have received satisfactory answers to all my questions and I have received enough information about this study. I understand that I am free to withdraw from this study at any time without giving a reason for withdrawing and without negative consequences. I consent to the use of multimedia (e.g. audio recordings, video recordings) for the purposes of my participation to this study. I understand that my data will remain anonymous and confidential, unless stated otherwise. I consent voluntarily to be a participant in this study.

Participant's Print name:

Participant's Signature: _____

Date:

If the Participant is illiterate:

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had an opportunity to ask questions. I confirm that the aforementioned individual has given consent freely.

Witness's Print name:

Witness's Signature: _____

Date:

[redacted]

5. REAF- DS

REAF_DS - Version 3.1

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RESEARCH ETHICS APPLICATION FORM
DOCTORAL STUDIES

UREC USE ONLY:
Application No:

Date Received:

Student's Name: Ochai Emmanuel Okpe

Student's E-mail Address: ochai.emmanuel@gmail.com

Student's ID #: R1807D5599078

Supervisor's Name: Dr Charoula Konstantia Nikolaou

University Campus: Unicaf University Zambia (UUZ)

Program of Study: UUZ: PhD Doctorate of Philosophy

Research Project Title: Understanding Health Information Systems and Decision-Making for Health: Case study using malaria data in Liberia

1. **Please state the timelines involved in the proposed research project:**

Estimated Start Date: 08-Aug-2022 Estimated End Date: 28-Feb-2023

2. **External Research Funding (if applicable):**

2.a. Do you have any external funding for your research?

☐ YES ☑ NO

If YES, please answer questions **2b** and **2c**.

2.b. List any external (third party) sources of funding you plan to utilise for your project. You need to include full details on the source of funds (e.g. state, private or individual sponsor), any prior / existing or future relationships between the funding body / sponsor and any of the principal investigator(s) or co-investigator(s) or student researcher(s), status and timeline of the application and any conditions attached.

2.c. If there are any perceived ethical issues or potential conflicts of interest arising from applying or and receiving external funding for the proposed research then these need to be fully disclosed below and also further elaborated on, in the relevant sections on ethical considerations later on in this form.

3. The research project

3.a. Project Summary:

In this section fully describe the purpose and underlying rationale for the proposed research project. Ensure that you pose the research questions to be examined, state the hypotheses, and discuss the expected results of your research and their potential.

It is important in your description to use plain language so it can be understood by all members of the UREC, especially those who are not necessarily experts in the particular discipline. To that effect ensure that you fully explain / define any technical terms or discipline-specific terminology (use the space provided in the box).

In most African countries, social and economic development is hindered due to a lack of information and information systems, especially health systems, for decision making and planning. United Nations MDGs. (2000). The desire to attain high-quality data that address health challenges in countries has become a considerable challenge; developing and strengthening health information systems (HMIS) at the country level becomes paramount. (WHO). To develop an understanding of the evolution and functionality of the health information system and its role in decision-making related to health planning, especially malaria prevention and control in Liberia. 1. How was the health management information system developed, and has it evolved in the past five years? 2. How reliable and appropriate is the malaria HMIS data for malaria control decision-making? 3. How has using HMIS data supported malaria prevention and control planning? 4. What will determine the supporting factors for effective HMIS strengthening for malaria control in the country? Ho: The developed health management information system is not reliable and appropriate for malaria control decision-making Ha: The developed health management information system is reliable and appropriate for malaria control decision-making Ho: The health management information system has not been pictured and used correctly. Ha: The health management information system has not been depicted and used correctly. Ho: Decisions on Malaria prevention and control have not been made using valid HMIS data. Ha: Decisions on Malaria prevention and control have been made using valuable HMIS data. This study, in its outcome, is expected to provide a body of knowledge on why health management information systems and evidence-based decision-making remain weak and how they can be strengthened sustainably in developing countries to improve the health system and reduce mortality rates through evidence-based interventions.

3.b. Significance of the Proposed Research Study and Potential Benefits:

Outline the potential significance and/or benefits of the research (use the space provided in the box).

The World Health Organization (2000) has described the health management information system (HMIS) in Africa as a huge challenge, which now makes decision-making and planning in the health sector very difficult to attain, especially in combating diseases like malaria. In Liberia, reliable and evidence-based decision-making becomes critical in the health system, especially in malaria control. NDHS. 2000. To address these data challenges and combat subsequent health challenges, the first step will be to develop and strengthen the Health Management Information System (HMIS) at the country level that will provide high-quality data through health facilities as significant sources of data collection. The second approach focuses on strengthening the national capacity to collect, analyse, interpret and use the data to make decisions in the country's health context. The apparent consequence of this data challenge is the limited availability of high-quality in-country data on which to base contextually relevant decisions that will contribute to planning and improving the health system. This research result will be presented to decision-makers and used to explore or recommend how evidence is perceived and used to (a) further strengthen the health information system and (b) inform decisions about malaria control that will further reduce mortality and improve population health stability.

4. **Project execution:**

4.a. The following study is an:

- [x] experimental study (primary research)
- [x] desktop study (secondary research)
- [x] desktop study using existing databases involving information of human/animal subjects
- [x] Other

If you have chosen 'Other' please Explain:

The experimental study aside primary facility data and secondary DHIS2 data will include observation and comparison of facilities to facilities data collection

4.b. Methods. The following study will involve the use of:

Method	Materials / Tools
Qualitative:	☑ Face to Face Interviews
	☑ Phone Interviews
	☐ Face to Face Focus Groups
	☐ Online Focus Groups
	☐ Other *
Quantitative:	☑ Face to Face Questionnaires
	☐ Online Questionnaires
	☐ Experiments
	☐ Tests
	☐ Other *

*If you have chosen 'Other' please Explain:

5. **Participants:**

5 a. Does the Project involve the recruitment and participation of additional persons other than the researcher(s) themselves?

☑ YES **If YES, please complete all following sections.**

☐ NO **If NO, please directly proceed to Question 7.**

5 c. Participation & Research setting:

Clearly describe which group of participants is completing/participating in the material(s)/ tool(s) described in 5b above (use the space provided in the box).

The group of participants will all be either data officer/M&E officers or record staff of sample Health Facilities in Liberia, this will also includes the malaria programme of the ministry of Health HMIS staff. The study tools will be pre-tested (administered at a Primary HF in the capital city) with key M&E and facility staff to ascertain language and clarity of data collection process before being rolled out to other facilities in the country. The research will identify such officers as mentioned above and selected randomly for the study through facilities selections, the health facility officers will participate in supporting the HMIS data collection and completing questions on the tools as respondents and as mentioned above.

5 d. Recruitment Process for Human Research Participants:

Clearly describe how the potential participants will be identified, approached and recruited (use the space provided in the box).

The potential participants will all be either data officer/M&E officers or record staff of primary, secondary and tertiary health facilities in Liberia and MOH staff as indicated earlier. The research will identify such officers as mentioned above at the randomly selected facilities for the study.
The research participants will be automatically selected by being the data/M&E officers of the selected facilities for the study.
All participants will be well informed and sensitized before hand to make a voluntary decision, however other participants from the national level will be chosen by the ministry or malaria program director considering the fact that they are either the custodians of the health data or in the data capturing processes.

5 e. Research Participants Informed Consent.

Select below which categories of participants will participate in the study. Complete the relevant Informed Consent form and submit it along with the REAF form.

Yes	No	Categories of participants	Form to be completed
☑	☐	Typically Developing population(s) above the maturity age *	Informed Consent Form
☐	☐	Typically Developing population(s) under the maturity age *	Guardian Informed Consent Form

* Maturity age is defined by national regulations in laws of the country in which the research is being conducted.

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6 b. Choose the appropriate option

		Yes	No
i.	Will you obtain written informed consent form from all participants?	☑	☐
ii.	Does the research involve as participants, people whose ability to give free and informed consent is in question?	☐	☑
iii.	Does this research involve participants who are children under maturity age? **If you answered YES to question iii, complete all following questions.** **If you answered NO to question iii, do not answer Questions iv, v, vi and proceed to Questions vii, viii, ix and x.**	☐	☑
iv.	Will the research tools be implemented in a professional educational setting in the presence of other adults (i.e. classroom in the presence of a teacher)?	☐	☑
v.	Will informed consent be obtained from the legal guardians (i.e. parents) of children?	☐	☑
vi.	Will verbal assent be obtained from children?	☐	☑
vii.	Will all data be treated as confidential? If NO, explain why confidentiality of the collected data is not appropriate for this proposed research project, providing details of how all participants will be informed of the fact that any data which they will provide will not be confidential.	☑	☐
viii.	Will all participants /data collected be anonymous? If NO, explain why and describe the procedures to be used to ensure the anonymity of participants and/or confidentiality of the collected data both during the conduct of the research and in the subsequent release of its findings.	☑	☐

10. Final Declaration by Applicants:

(a) I declare that this application is submitted on the basis that the information it contains is confidential and will only be used by Unicaf University for the explicit purpose of ethical review and monitoring of the conduct of the research proposed project as described in the preceding pages.

(b) I understand that this information will not be used for any other purpose without my prior consent, excluding use intended to satisfy reporting requirements to relevant regulatory bodies.

(c) The information in this form, together with any accompanying information, is complete and correct to the best of my knowledge and belief and I take full responsibility for it.

(d) I undertake to abide by the highest possible international ethical standards governing the Code of Practice for Research Involving Human Participants, as published by the UN WHO Research Ethics Review Committee (ERC) on http://www.who.int/ethics/research/en/ and to which Unicaf University aspires to.

(e) In addition to respect any and all relevant professional bodies' codes of conduct and/or ethical guidelines, where applicable, while in pursuit of this research project.

☑ **I agree with all points listed under Question 10**

Student's Name: Ochai Emmanuel Okpe

Supervisor's Name: Dr Charoula Konstantia Nikolaou

Date of Application: 28-Jul-2022

Important Note:
Save your completed form (we suggest you also print a copy for your records) and then submit it to your UU Dissertation/project supervisor (tutor). **In the case of student projects, the responsibility lies with the Faculty Dissertation/Project Supervisor.** If this is a student application, then it should be submitted via the relevant link in the VLE. Please submit only electronically filled in copies; **do not** hand fill and submit scanned paper copies of this application.

Appendix B: Useful Resources

Appendix B: RESEARCH TOOLS

Understanding Health Information Systems and Decision-Making for Health: Case study using malaria data in Liberia

Data collection tools

The primary purpose of the survey is to assess the malaria Health Information Systems and Decision Making in the Liberia health system as a Case Study.

KEY INFORMANT INTERVIEWER'S GUIDE (Key staff and Project Management Team of the country ministry of health and of health facilities**) face to face and Phone interview –** PMT & Facility doctors in charge and data officers

Confidentiality and Consent: We must assure our respondents that all information gathered from this exercise will not be shared with anybody out the purpose of the study in which we are undertaking. And seek their consent to participate and take pictures if need be

Demographic information

1. Position:
2. Department:
3. Number of staff supervised:
4. County/District supervised:

1. **Questions - (observations and case studies will be engaged at this level of questions from Q1 to Q3)**
2. Briefly describe the health system data collection process. (Be attentive to be sure they all have the same idea)

3. What data collection tools are used in the process at every level of facilities? (Data flow
4. What platform(s) are used for data storage and management?
5. Do you have partners supporting health data management in the health sector?
6. What is the partner's role in data management? (Explore issues related to technical support and management, technical oversight etc.)

Relevance

7. What do you think the data management team has done well? What would they have done better?
8. What is the donor's perception on the achievements of the health data management in relation to the expected outcomes in: Institutional Capacity Building and facilities individual capacity?

Efficiency

9. How would you rate data performance and demand so far?
10. What has been done with data in the country or how will you describe data use for health systems decision-making?
11. What do you think can be done better?

Effectiveness

12. Would you say the objectives of data management for decision-making has been achieved and on time?
13. Were there some challenges or successes that influenced the achievement or non-achievement of the health information system?

Sustainability

1. How has the health information system improved the technical skills/capacity of the health system? (Probe for malaria interventions)
2. What were the significant factors that influenced the achievement or non-achievement of sustainability of the health information system?

Impact

3. What has happened due to the good/weak/bad health information system?
4. What real difference has the Health information system made to the health system?

Data quality and control – The specific DHIS2 lead and the HMIS officer for the country will be interviewed (just 2 participants).

Confidentiality and Consent: We must assure our respondents that all information gathered from this exercise will not be shared with anybody out the purpose of the study in which we are undertaking. And seek their consent to participate and take pictures if need be

Demographic information

1. Position:
2. Department:
3. Number of staff supervised:
4. County/District supervised:

Questions

1. Is there an M&E plan for quality data check? Describe, please (just for M&E and data staff)
2. What is the facility's data collection process? (Please compare with the M&E plan)
3. What are your sources of data?
4. Is data analysed at facility level/county level? According to the M&E plan?
5. Is compilation and record keeping at source?
6. How do you store your data?
7. Do you have a data flow chart? Describe how data flows from the facility to the central database
8. Is the malaria programme using intervention information for decision-making purposes? (County office)
9. Is the health information system supporting the national reporting systems? (Facility to LGA to county and MOH)
10. What are the good practices and lessons learned?

Questionnaire (face to face) with key Health Facility staffs

The focus on these sampled health facility The result of this survey will be used to generate a summary report for the Liberia malaria HMIS study.

Confidentiality and Consent: We must assure our respondents that all information gathered from this exercise will not be shared with anybody outside the purpose of the study which we are undertaking. And seek their consent to participate and take pictures if need be

Section A: Demographics

1. Position:
2. Years of service:
3. Age bracket:
4. Region/County:

2. Type of data storage used in the facility.

_____

_____

_____

_____