Determinants of Translating Routine Health Information System Data into Action

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Abstract

Determinants of Translating Routine Health Information System Data into Action

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Introduction Use of routine health information system (RHIS) data to inform improvements to health facility performance is an essential approach to achieving universal health coverage, but RHIS data use remains limited in many low- and middle-income countries. There is a lack of consensus and consistency in how RHIS data use is conceptualized and measured in the literature and determinants of translating RHIS data into action are not well understood, impeding the development and evaluation of effective RHIS data use interventions.

Methods The overall goal of this dissertation was to identify the determinants of translating RHIS data into action to inform the development of more effective and targeted interventions that promote decisions and actions based on quality RHIS data. To this end, a systematic integrative review was conducted to summarize the current state of the RHIS data use literature

to inform the development of a common definition for RHIS data use, refine a popular data use framework to clarify what encompasses data use, and propose improvements to measuring data use. The refined framework was then used to guide qualitative and quantitative studies that explored the determinants of translating RHIS data into action.

Results Findings from all three studies indicate that RHIS data use is a multi-step process where data-informed action is the critical last step that contributes to improvements in health system performance. In the qualitative exploration, regular facility meetings to review RHIS data to assess health facility performance was identified to be an essential determinant in implementing planned actions informed by RHIS data. Findings from the quantitative exploration indicated that the more actions a facility planned, the more likely the facility was to implement those actions. In both qualitative and quantitative explorations, facility staff experience of insufficient health workers was a barrier to translating RHIS data into action.

Conclusion Future studies and implementation strategies should be designed with consideration for the different support needs for each step of the RHIS data use process.

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Chapter 1. Introduction

Background and significance

Universal health coverage

Universal health coverage (UHC), rooted in the principle that health is a human right, is about ensuring that all people have access to quality health services when and where they need it without financial hardship [1]. UHC is a critical milestone in achieving the Sustainable Development Goals: a healthy population means children can learn and adults can earn, contributing to inclusive socio-economic growth [1-3]. While there has been enormous global commitment to achieving UHC [4], half of the world's population continue to lack access to essential health services [5].

Improving health system performance through investments in the use of routine health information system (RHIS) data has been recognized as a critical element to achieving UHC in lower- and middle-income countries (LMICs) [6-8]. This aligns with the World Health Organization's framework for health systems strengthening, which points to the foundational role of the health information system in informing data-driven decisions and actions in the other health system building blocks: financing, leadership and governance, health workforce, service delivery, and essential medicines [9].

Routine health information systems in the context of decentralization

RHIS are characterized by systems that ensure the production, analysis, and use of data at intervals of less than a year [10, 11], to inform status of health system performance such as quality and quantity of health services delivered [12]. Widespread adoption and implementation of health system decentralization in LMICs has meant that decision-making responsibilities to manage health services has shifted to officials at the local levels, particularly to facility and

district or equivalent administrative levels [13, 14]. Decentralization is theorized to contribute to improved primary health service provision, by allowing local officials to manage service delivery to be more responsive to local needs [13, 14]. Many have conceptualized a synergistic relationship between RHIS and decentralization, in that decentralization encourages health system managers to use RHIS data to make decisions and take action, while the availability of RHIS data generated at the health facility enables a decentralized health system [14-18].

Routine health information system data use and evidence gaps

RHIS data use remains low across many LMICs, with many collecting large amounts of data but never analyzing and reviewing it to inform decisions and actions to improve health system performance [8, 10, 18-24]. Many health facilities also suffer from "mailbox syndrome," in which RHIS data is sent to higher administrative levels for analysis or reporting, without use at the facility to inform improvements [24-27]. Even when decisions are made based on RHIS data, decisions often do not lead to action [19, 28, 29], which is ultimately what is needed to improve health system performance and population health.

Recent systematic reviews on RHIS data use have noted the lack of consensus and consistency in how RHIS data is conceptualized and measured [29, 30], impeding the development, evaluation, and identification of effective RHIS data use interventions. Furthermore, determinants that influence RHIS data-informed decisions and actions are not well understood, and few studies have explored the relationship between RHIS data-informed decisions and actions [11, 30-35]. Relatedly, most RHIS data use interventions focus on improving data analysis capacity through changes to the technical design of the RHIS itself or training health workers [10, 28, 30, 31] and do not move beyond data analysis to support the translation of data into action.

Intervention description

The Integrated District Evidence to Action (IDEAs) strategy aimed to improve health system performance by supporting district and health facility staff in Central Mozambique to make data-informed decisions and implement evidence-based actions that are low-cost and align with organizational priorities. IDEAs united provincial, district, and health facility managers to regularly analyze and review health facility performance using RHIS data and develop and monitor action plans to improve facility services for women, newborns, and children.

Dissertation aims

The overall goal of this dissertation was to identify determinants of translating RHIS data into action to inform the development of more effective, targeted interventions that promote decisions and actions based on quality RHIS data. Three specific aims were pursued to accomplish this goal, described in Chapters 2-4.

Chapter 2 describes the methods and findings from an integrative review used to summarize the current state of the RHIS data use literature and take a comprehensive approach to fully understand the concept of "RHIS data use." The findings of the review informed the refinement of the Performance of Routine Information System (PRISM) framework, the development of a common definition for RHIS data use, and proposed improvements to measuring RHIS data use.

Chapter 3 describes the methods and findings from a qualitative exploration of the determinants and characteristics of data-informed decisions at the facility-level that successfully led to action in Mozambique and which of these determinants the IDEAs strategy influenced. The refined PRISM framework developed through the integrative review described in Chapter 2 served as the conceptual framework for this qualitative exploration.

Chapter 4 describes the methods and findings from longitudinal analyses conducted to identify factors associated with successful translation of RHIS data into action among health facilities in Mozambique that participated in the IDEAs strategy. Findings from the integrative review and qualitative exploration informed the selection of predictors in the analysis.

Chapter 2. Refining the Performance of Routine Information System Framework (PRISM) for data use: An integrative review

Abstract

Introduction At the foundation of a well-functioning health system is a strong routine health information system (RHIS) that informs decisions and actions at all levels of the health system. In the context of widespread decentralization across low- and middle-income countries (LMICs), RHIS data has the promise of supporting sub-national health staff to make data-informed decisions and actions to improve health system performance. However, there is wide variation in how "RHIS data use" is defined and measured in the literature, impeding the development and evaluation of interventions that effectively promote RHIS data use.

Methods An integrative review methodology was used to: (1) synthesize the state of the literature on how "RHIS data use" at the sub-national level in LMICs is conceptualized and measured; (2) propose a refined "RHIS data use" framework and develop a common definition for "RHIS data use"; and (3) propose improved measurement approaches for RHIS data use. Four electronic databases were searched for peer-reviewed articles published between 2009 and 2021 investigating RHIS data use.

Results A total of 45 articles, including 24 articles measuring RHIS data use, met the inclusion criteria. Less than half of included articles (42%) explicitly defined "RHIS data use" and many of these definitions focused on the application of data use (47%), such as for program planning and improvement, rather than the actual steps that encompass data use (26%), such as problem identification and prioritization. There were differences across the literature whether RHIS data tasks such as data analysis and review preceded or were a part of RHIS data use; there was broad consensus that data-informed decisions and actions were essential steps within RHIS data use.

Based on the synthesis, the Performance of Routine Information System Management (PRISM) framework was refined to specify the steps within RHIS data use, including data review, data-informed decisions and actions, and monitoring, evaluation, and learning.

Conclusion Conceptualizing RHIS data use as a process that includes data-informed actions emphasizes the importance of actions in improving health system performance. Future studies and implementation strategies should be designed with consideration for the different support needs for each step of the RHIS data use process.

Introduction

At the foundation of a well-functioning health system is a health information system that informs decisions and actions regarding health system financing, leadership and governance, health workforce, service delivery, and essential medicines [9]. Routine health information systems (RHISs) are implemented at scale in low- and middle-income countries (LMICs) and inform decision making at all levels of the health system [36-38]. RHISs are characterized by systems that ensure the production, analysis, and use of data at intervals of less than a year, to generate information regarding health system performance such as quantity of health services delivered [10, 11].

Widespread adoption and implementation of health system decentralization in LMICs has meant that decision making responsibilities to manage health services has shifted to officials at the local levels, particularly to facility and district or equivalent administrative levels [13, 14]. Decentralization is theorized to contribute to improved primary health service provision, by allowing local officials to manage service delivery to be more responsive to local needs [13, 14]. Some have conceptualized a synergistic relationship between RHIS and decentralization, in that decentralization encourages local health system managers to use RHIS data to make decisions

and take action, while the availability of RHIS data generated at the health facility enables a decentralized health system [14-18]. There is also evidence that when frontline health workers, who are typically responsible for collecting RHIS data, are engaged in using the data themselves to inform clinical practice and service delivery, they come to see the value of the data, leading to improvements in data quality and data-informed decision making [17, 22, 23, 29, 39].

However, RHIS data use remains low across many LMICs, with many countries collecting large amounts of data but never analyzing and reviewing it to inform decisions and actions to improve health system performance [8, 10, 18-24]. Many health facilities also suffer from "mailbox syndrome," in which RHIS data is sent to higher administrative levels for analysis or reporting, without use at the facility to inform improvements [24-27]. Additionally, recent systematic reviews have found that many RHIS data use interventions focus on strengthening the data collection and analysis skills of health workers [10, 11, 29, 31, 40], but do not focus on the critical step of translating data into action [19, 28, 29], which is what is ultimately needed to improve health system performance and population health. A leading RHIS data use expert called out this gap in a 2017 editorial:

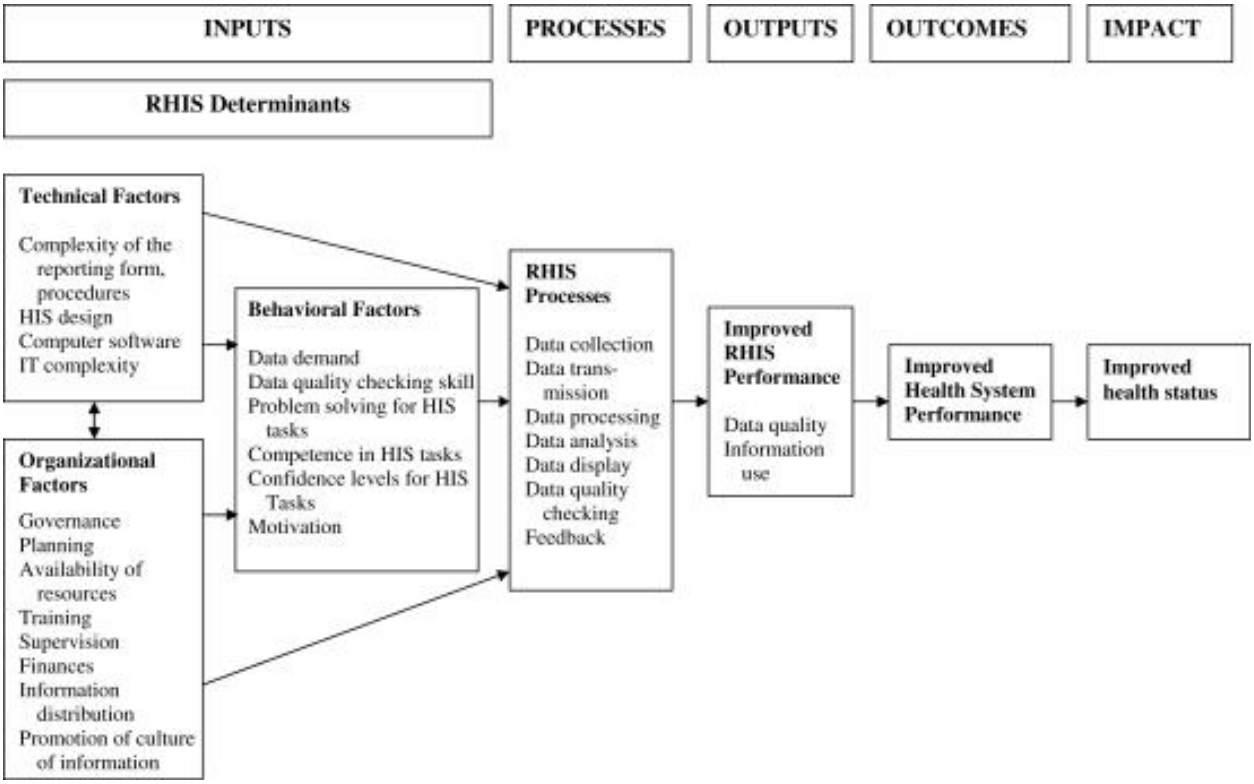
> "Most efforts to strengthen health facility and community health information systems are focused on… identifying problems. But the ultimate goal of RHIS is that information is used to solve problems and to improve access to and delivery of quality health services. This last step of translating data into action is the most challenging" [28].

This highlights that "RHIS data use" is a multi-step process, whereby identifying problems and taking action are crucial, distinct steps within the "RHIS data use" process. However, RHIS data use papers often do not detail what steps are included within the "RHIS data use" process.

In the Performance of Routine Information System Management (PRISM) framework [15] (Figure 1), a popular framework used to evaluate and inform the development of RHIS strengthening interventions in LMICs, there is a direct pathway from improved RHIS data

quality and use to improved health system performance, and it is unclear whether, where, or how data is translated into action. Accordingly, some studies using the PRISM framework have called for a need for more clarity in conceptualizing the complex relationship between RHIS data, data use, decision making, and health system impact [11, 22, 30].

Figure 1. Performance of Routine Information System Management (PRISM) framework [15]



Relatedly, systematic reviews have noted the lack of consensus and consistency in how RHIS data use is conceptualized and measured [29, 30], impeding the development, evaluation, and identification of effective RHIS data use interventions. To date, there has not been a comprehensive review of how "RHIS data use" is conceptualized and measured in the literature.

The purpose of this integrative review was to synthesize published literature on "RHIS data use" at the district and health facility-levels in LMIC settings, in order to inform the refinement of the PRISM framework, identify a common definition for RHIS data use, and propose improved measurement approaches to move the RHIS data use field forward.

Methods

An integrative review methodology was used to summarize the current state of the literature and take a comprehensive approach to fully understand the concept of "RHIS data use." Integrative review is a type of systematic review method that summarizes past literature to provide a more comprehensive understanding of a particular phenomenon [41]. The process of systematically analyzing, visualizing, and comparing data from literature enables the identification of patterns and themes to generate new or revised concepts and frameworks [42, 43]. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2020 guidelines were followed in the reporting of this review [44].

Rather than developing a new conceptual framework for RHIS data use, the PRISM framework [15] was selected for refinement. PRISM was selected as it is the only health information system framework developed specifically for RHISs and with the LMIC context in mind [11, 23]. The PRISM framework is also a foundational framework in the RHIS data use literature, with the framework and its associated data collection tools used widely across the literature.

Eligibility criteria

Studies included in this review were peer-reviewed research papers published in English investigating RHIS data use at the district or health facility level in LMIC settings (Table 1). For the purposes of the search and selection process, RHIS data use was defined broadly as any consideration of RHIS data to inform health system management decisions or actions. Studies were excluded if RHIS data use was not part of the main findings but instead discussed in the background or discussion sections only. Articles reporting results from RHIS implementation or data quality assurance activities without directly investigating and reporting on RHIS data use

were excluded. Literature review and synthesis papers, as well as studies using quantitative, qualitative, or mixed methods designs were included. Given that the PRISM framework was published in 2009 and the rapid advancements in this field, searches were limited to those published between 2009 and 2021, to capture the most current understanding and practices on this topic.

Table 1. Study eligibility criteria

Inclusion criteria	Exclusion criteria
Published in peer-reviewed scientific journals	Grey literature
Studies of any design (quantitative, qualitative, mixed methods, synthesis) investigating data use at the district or health facility-level	Studies not focusing on RHIS data use Studies of RHIS data use at the global, national, and/or regional-levels Research protocols, editorials, description of interventions
Studies conducted in LMICs according to the Development Assistance Committee list [45]	Studies conducted in high-income countries
Studies published in English	Studies in languages other than English
Studies published from January 2009 to December 2021	Studies published before January 2009

Information sources and search strategy

The following databases were systematically searched in January 2022 to identify potential papers: EBSCO CINAHL, EBSCO Global Health, Embase, and PubMed. A combination of search terms was used to identify published studies (Table 2). Databases and search terms were selected based on the primary purpose of the review and previous reviews of similar topics [10, 11, 31, 34]. Reference lists of included systematic review articles were also searched to identify additional publications.

Selection process

All article records identified through the database search were exported into Excel; articles identified through the reference list search were entered into the same spreadsheet. Upon identification and removal of duplicate records, titles and abstracts of remaining articles were screened and classified by two reviewers as “eligible” or “ineligible,” citing the relevant eligibility criteria. Full-text articles of all articles identified by at least one reviewer as eligible

were then reviewed and further classified as eligible or ineligible by both reviewers, noting reasons for exclusion. Any disagreements in selection were discussed and resolved.

Table 2. Search terms used for review

First term		Second term
Routine health information system or health management information system	and	Data use or data utilization or Information use or information utilization or Data-informed or data-driven or Decision making or Quality improvement or Data to action or Audit and feedback
Data use or data utilization or Information use or information utilization or Data-informed or data-driven or Decision making or Quality improvement or Data to action or Audit and feedback	and	Measure
Performance of Routine Information System Management		

Data collection process, data items, and synthesis

Data use concept: Terminology, definitions, application, and steps

All included articles were read and coded by an analyst in ATLAS.ti (v8) using the initial codes "terms," and "definition." To systematically apply codes, a codebook was developed with code definitions, inclusion and exclusion criteria, and examples. Upon completion of initial coding, the ATLAS.ti search term and Word List functions were used to identify and code any additional data use terminology (i.e., data use synonyms) used across all included articles. Coding reports were exported into Excel for synthesis.

To synthesize the terminology data, similar data use terms were combined to create umbrella terms. For example, "use" and "utilization" were combined to be "data use/utilization." Differences in ordering of terms were also merged into one term, for example, "use-of-information" was categorized under "information use/utilization." Summary statistics were calculated to assess which words were most used across articles included in this review.

Summary statistics were calculated to assess what percentage of articles explicitly defined data use. Thematic analysis of data use definitions was conducted to group similar definitions. Through this process, the themes of "application" and "steps," emerged, in that some articles defined data use by its application and others by its steps. All articles were then reviewed to apply the codes "application," in other words, for what purposes data is used such as for planning and monitoring purposes, and "steps," which was inclusive of any RHIS data tasks such as data collection, data analysis, and decision making based on data. Coding reports were then exported into Excel for synthesis.

Application data was used to create a full list of data use applications and then assessed to determine which data use applications were most noted across articles by distinct first authors. Similar applications were combined to create umbrella applications. For example, "budgeting" and "resource allocation," were grouped into one umbrella "budgeting/resource allocation" application.

To synthesize the data use steps data, the ATLAS.ti coding report informed the development of a comprehensive list of RHIS data tasks. Extracted text were then assessed to fall under these RHIS data tasks and color coded based on whether the authors implied the task to be a separate or inclusive part of the "RHIS data use" process. For example, if the extracted text said, "data analysis, interpretation, and use," we specified that "data analysis," and "interpretation," were RHIS data tasks that were not a part of "data use," whereas if the extracted text said, "The 'use' of data is the analysis, synthesis, interpretation, and review of data as part of a decision-making process," [30] then we noted that data analysis, synthesis, interpretation, review, and decision making were inclusive of the data use process.

Data use measurement

A "data use measurement" data collection tool was designed, tested, and refined by the investigators to extract data from articles on approaches to measuring RHIS data use. Design of the items in the tool were guided by measurement sciences principles [46-49] and included:

- Author, publication year, title, and country,
- Study design,
- Data collection tool used (e.g., questionnaire) and its source (e.g., PRISM toolkit),
- Number of items in the tool,
- Items in the tool (e.g., the actual questions and response options such as Yes/No), and
- How the data use measure was calculated.

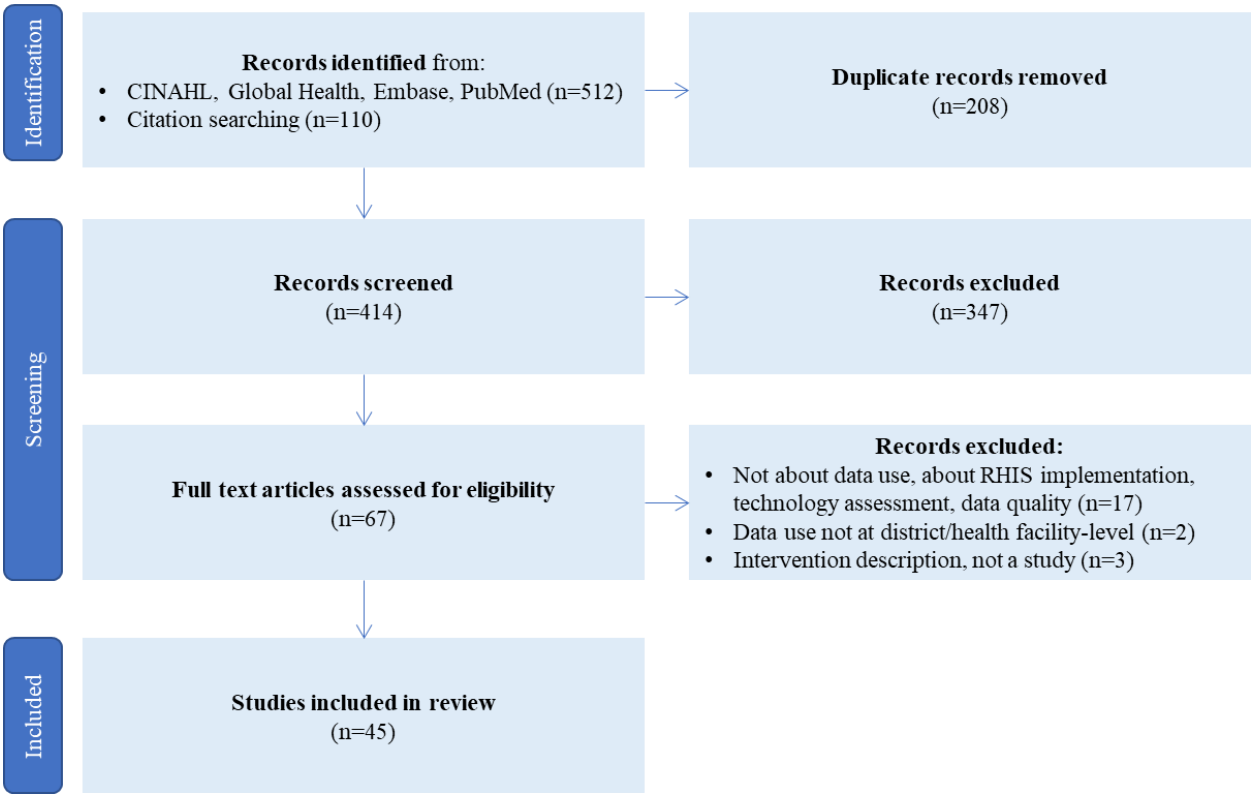
Risk of bias and certainty of evidence assessments were not conducted because the focus of the review was methodological and not concerned with conducting statistical analyses of the study results.

Results

Study selection

A total of 622 articles were identified: 512 through the database searches and an additional 110 through citation searching. After removing duplicates, 414 articles remained and were screened based on their title and abstract. Of these, 347 were excluded, primarily because they were off-topic or outside the geographic scope of the study. 67 full-text articles were assessed for eligibility, of which 17 were excluded because they focused on other aspects of RHIS such as implementation and data quality. A total of 45 articles met the inclusion criteria. Figure 2 summarizes the study identification, screening, and selection process.

Figure 2. Study selection process



Study characteristics

There was a nearly even distribution of study designs used by the papers included in the review (Table 3). A few studies reported to use mixed-methods for the overall study but only used qualitative methods to assess data use; these were classified as qualitative studies. Among the 24 articles using quantitative methods, 10 articles (42%) used descriptive analysis to report data use as a count and/or percentage and did not conduct any inferential analysis. 10 articles (42%) conducted tests of association to assess what determinants were associated with data use, three used a pre/post design to assess change over time, and one tested the reliability and validity of the PRISM data collection tool. The median publication year was 2020, with more than half of the articles (53%) published between 2020 and 2021. The vast majority of the 33 original

research articles were conducted in sub-Saharan Africa (73%), with studies conducted in Ethiopia accounting for more than a third of all original research articles (36%).

Table 3. Study characteristics

Characteristics	n (%), unless noted
Study design (N=45)	
Qualitative	9 (20%)
Quantitative	12 (27%)
Mixed methods	12 (27%)
Synthesis	12 (27%)
Published year, median (range)	2020 (2009-2021)
Regions (N=33[a])	
Ethiopia	12 (36%)
Central and West Africa	5 (15%)
Eastern and Southern Africa	7 (21%)
Asia	7 (21%)
Multiple regions	2 (6%)

[a] Original research articles only, excludes synthesis articles

What is meant by "RHIS data use"?

Terminology

A total of 17 terms for "RHIS data use" were identified (Table 4). Terms used across the greatest proportion of papers were "data use" (89%), "information use" (71%), "data use for/in decision making" (58%), and "evidence-based/informed decisions" (51%). Most papers used several different terms, at an average of four terms per paper and one paper using eight different terms. "Decisions" and "decision making" were common additions to the terms "data use" and "information use."

Table 4. Number (%) of articles using specified data use terms (N=45)

Data use terms	n (%)
Data use	40 (89%)
Information use	32 (71%)
Data use for/in decision making	26 (58%)
Evidence-based/informed decisions	23 (51%)
Data-based/driven/informed decisions	15 (33%)
Information use for/in decision making	12 (27%)
Information use for evidence-based decisions	8 (18%)
Other	8 (18%)

Definition

Among the 45 articles reviewed, less than half (42%) explicitly defined "RHIS data use." While there was some commonality across data use definitions (Appendix A: Definitions reported by articles), there was not a commonly accepted and cited definition for "RHIS data use." Nearly half of the definitions (47%) focused on the application of RHIS data use, while about a quarter (26%) focused on the steps involved in RHIS data use. The most common word used when defining data use was "decision." A few articles explicitly defined decision making.

Application

Among the 45 articles reviewed, most (84%) described how RHIS data could be used by districts and health facilities, including "in policymaking, planning, management, and service delivery" [11]. Data use applications noted by the greatest proportion of papers with distinct first authors were improvement of program/service delivery (76%), planning (71%), and performance monitoring and evaluation (68%) (Table 5). General planning, prioritization, and management were commonly mentioned and were kept separate from specified management activities such as human resource management and drug/commodities management to reflect how these were presented in the papers.

Table 5. Number (%) of articles specifying data use applications (N=38)

Data use applications	n (%)
Service delivery/program improvement	29 (76%)
Planning	27 (71%)
Performance monitoring and evaluation	26 (68%)
Policy/strategy development	19 (50%)
Budget/resource allocation	19 (50%)
Management	17 (45%)
Human resource management	10 (26%)
Drug/commodity management	9 (24%)
Prioritization	8 (21%)
Patient clinical care	8 (21%)
Disease detection and prioritization	8 (21%)
Advocacy	7 (18%)
Reporting	7 (18%)
Data quality assessment	2 (5%)

Steps

Among the 45 articles reviewed, very few (11%) explicitly described the steps that take place when RHIS data is "used," i.e., answering "What does data use look like?" One study centered their definition of data use around the steps included in the data use process, which were "problem identification, prioritization, action plan development, implementation, and following-up, and providing regular feedback" [50]. Most studies (64%) noted various RHIS data-related tasks; 17 distinct tasks were identified. Among these, 25 articles and 21 distinct first authors implied these tasks to be a separate or inclusive part of the RHIS data use process. There was consensus that RHIS data collection and recording, transmission, and processing were not a part of data use and that problem identification, prioritization, solving, decision making, action planning, action taking, and monitoring/follow-up were a part of data use (Table 6). There was some disagreement about the other RHIS data tasks but generally, data quality assessments, data analysis, dissemination of data (through presentation or display of data visualizations), reporting, and data interpretation were not considered to be a part of the data use process. Review and discussions about data were generally considered to be a part of data use.

Table 6. Classification of consensus regarding RHIS data tasks (N=25)

RHIS data tasks	Part of data use?	
	No	Yes
Collection/recording	11	0
Transmission	2	0
Processing	7	0
Data quality assessment	3	1
Data analysis	13	3
Dissemination (presentation, display)	6	2
Reporting	10	2
Interpretation	8	3
Review	2	4
Discussion	1	4
Problem identification	0	2
Problem prioritization	0	2
Problem solving/decision making	0	6
Action planning	0	3
Action	0	2
Monitoring/follow-up	0	3

Legend
- Consensus, not data use
- Some disagreement, leans not data use
- Some disagreement, leans data use
- Consensus, data use

How is RHIS data use measured?

Among the 24 studies measuring RHIS data use, more than half (54%) used an adapted version of the PRISM toolkit (Table 7). The PRISM toolkit is a suite of six different data collection tools to aid in the assessment of RHIS performance [51]. In particular, the RHIS Performance Diagnostic Tool collects data to measure data use at the district-level as well as at the facility-level. The toolkit was initially developed by MEASURE Evaluation in 2011 [52] and then updated by MEASURE in 2019 [51]. The 2011 RHIS Performance Diagnostic Tool at the facility-level contains 26 items mostly with Yes/No response options, compared to the 2019 tool with 32 items with Yes/No response options as well as categorical, numeric, and open-ended response options.

Table 7. Approaches to measuring RHIS data use (N=24)

Data collection tool, source	n (%)
PRISM (adapted)	13 (54%)
Developed by study	8 (33%)
Other	2 (8%)
Not reported	1 (4%)
Data collection tool, type	
Questionnaire only	8 (33%)
Observation/document review tool only	7 (29%)
Both (questionnaire + observation)	7 (29%)
Program data	1 (4%)
Not reported	1 (4%)
Data collection tool, number of items	
1-5	6 (25%)
6-10	5 (21%)
11+	6 (25%)
Not reported	7 (29%)
Data use measure	
Binary	11 (46%)
Categorical	1 (4%)
Continuous	2 (8%)
Not reported/calculated	10 (42%)

Among the 13 studies using an adapted version of the PRISM toolkit, there was wide variation in the approach to measuring data use. For example, one study using the PRISM toolkit only used one item to measure data use [53], while another study using the toolkit measured data use through 13 questionnaire items and 8 observation tool items [54]. Though the PRISM

framework clearly delineates “data analysis” and “data display” as part of RHIS processes that precede data use, a quarter of the studies (25%) included data analysis and/or data display measures as part of their “data use” measure. It was not possible to assess this for nearly a third of the studies (29%) because they did not report what items they collected to measure data use.

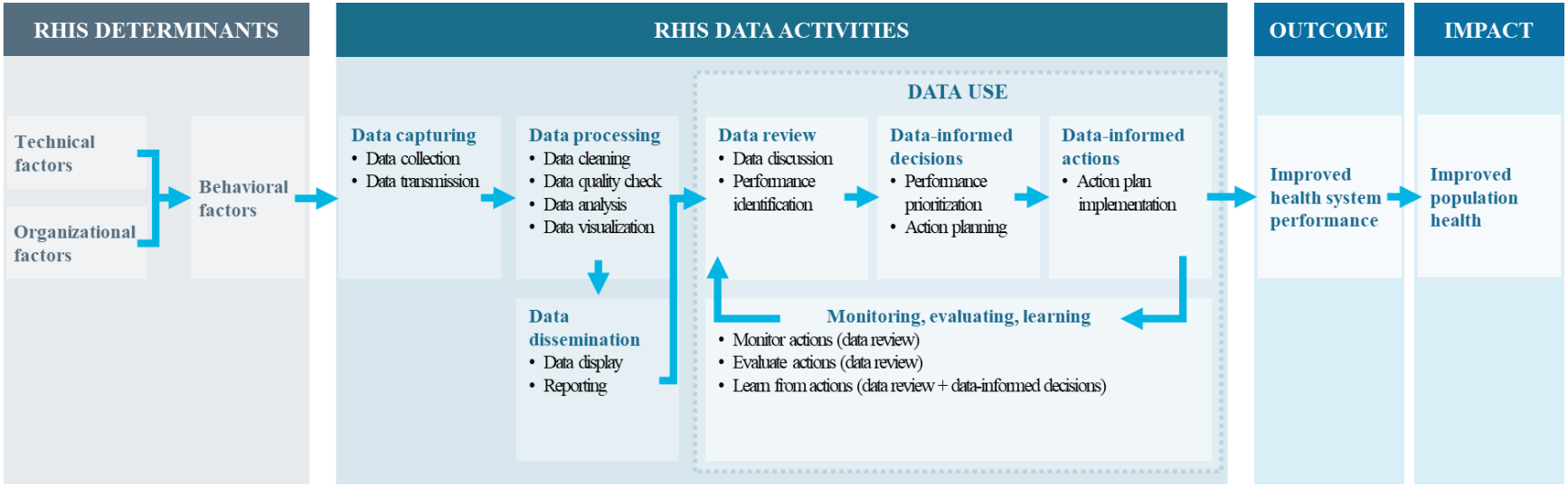
Most studies used a questionnaire (33%), observation or document review (29%), or both (29%) to measure data use. The exception was a study that developed a decision tracking system which served as their data source for the number and types of decisions taken and actions planned and completed [55]. About a third of studies (33%) collected self-reported measures about data use from health facility and/or district-level staff, without verification through observations or document review.

The number of items used to measure data use varied widely, ranging from one to 33 items, with a median of eight items. Nearly half of the studies (42%) either did not calculate or report an overall “data use” measure, instead reporting on the percentage of health facilities that said yes or no to individual tool items. Studies testing the association of “data use” with data use determinants commonly transformed the data use measure into a binary variable (e.g., good/poor data use). Mean or median values were commonly used as the cut-off for defining binary variables. A summary of measurement approaches of reviewed studies is available in Appendix B: Data use measurement approaches reported by articles.

Refining the PRISM framework: The PRISM-Act framework

Findings from this review informed the refinement of the PRISM framework, “PRISM-Act” (Figure 3). The “RHIS processes” and “information use” boxes in the original PRISM framework were expanded in the PRISM-Act framework to include more steps to reflect all the RHIS data tasks described in synthesized literature and clarify their relationship to one another.

Figure 3. PRISM-Act framework



The “data processing” and “data dissemination” boxes clarify that these RHIS data tasks are not a part of data use; instead, they are preceding steps to data use. These address major conceptual and measurement issues identified in the literature. First, despite general agreement among authors that data processing and dissemination are not a part of data use, many studies continue to include data analysis and data display as part of their data use measure. Measuring, strengthening, and monitoring data analysis capacity at the district and health facility-levels is important, but it is imperative to recognize that data analysis alone will not translate data into action nor lead to improvements to health system performance. Secondly, despite the frequency in which “reporting” is mentioned across the RHIS data use literature, this RHIS data task does not appear in the original PRISM framework. Given the issue of “mailbox syndrome,” where analyzed RHIS data is reported to higher levels but not used to inform decisions and actions at the health facility [24-27], and general agreement that reporting is not a part of data use, this step was added to the framework and presented as conceptually separate from data use.

In the PRISM-Act framework, “data use” has been conceptualized to be a multi-step process. Once data has been captured and processed, the data is ready to be reviewed. During the review, discussions take place to identify performance strengths and gaps; decision making is not a central focus of this step. Data review informs decisions regarding district or facility priorities and action steps. This is then followed by a step that focuses on acting on these decisions; again, decision making is not a central focus of this step. This is the critical step where data is translated into action, and it is these actions that ultimately lead to improvements in health system performance that increase access to quality care. Actions are then monitored and evaluated to assess action progress and impact, and the learnings from this step inform the start of another cycle of review, decisions, and actions.

By incorporating the data use terminology, definitions, and steps identified during the synthesis of the literature, the refined PRISM-Act framework clearly answers the questions, "What is RHIS data use and what is its relationship to decision making? What does RHIS data use look like? How do we know that data has been 'used'?

Proposed RHIS data use definition

Findings from this review informed the development of the definitions for RHIS data use and related terms used in the refined PRISM-Act framework. Definitions for these terms were primarily extracted from three articles [18, 19, 50] and merged; these are presented in Table 8.

Table 8. Proposed RHIS data use terminology and definitions

Terminology	Definition
RHIS data use	The process by which health staff 1) review analyzed RHIS data to identify performance strengths and gaps (performance identification), 2) collectively decide on performance priorities (performance prioritization), 3) collectively decide on action steps to build on performance strengths and/or address performance gaps (action planning), 4) implement selected action steps (action plan implementation), and 5) continuously monitor, evaluate, and learn from the implementation process (monitoring, evaluating, learning).
Performance identification	A step in the RHIS data use process, by which health staff define and identify performance strengths and gaps, including analyses of the reason for the gaps.
RHIS data-informed decision	A step in the RHIS data use process, by which health staff review analyzed RHIS data to reach a collective decision about priorities and action steps.
Performance prioritization	A step in the RHIS data use process, by which health staff identify performance priorities, including identification of which gaps should be addressed.
Action planning	A step in the RHIS data use process, by which health staff generate, compare, and select solutions and make plans to implement the solutions, such as identification of resources needed and responsible persons.
RHIS data-informed action	A step in the RHIS data use process, by which health staff implement action steps based on RHIS data-informed decisions.
Action plan implementation	A step in the RHIS data use process, by which health staff implement action plans, including resource acquisition.
Action plan monitoring, evaluation, and learning	A step in the RHIS data use process, by which health staff monitor progress on the action plan, evaluate its impact on the priorities, and learn from the process and make adjusted as needed.

Discussion

This review identified 45 papers investigating RHIS data use at the district or health facility-level in LMICs, of which 24 measured RHIS data use. More than a third of the 33 original research articles were from Ethiopia, which may be explained by Ethiopia's commitment to an

"information revolution," with particular emphasis on enhancing RHIS data use at the local administrative levels [19, 50, 56-58].

Text analysis of selected studies revealed that there is a lack of consensus and consistency in using terms to describe "RHIS data use" and studies often do not provide a definition for "RHIS data use." This is consistent with recent systematic review findings of a need for more clarity and consensus in conceptualizing and measuring data use [29, 30]. There were also differences in whether to define data use by its application or by the steps it encompasses. Data use definitions more commonly answered the question, "For what purposes can the data be used?" and were less likely to answer the questions, "What does data use look like? How do we know that data has been 'used'?"

Both data use terminology and definitions used in the literature indicate that data use is strongly connected with decision making, but there lacked clarity and consistency about whether data use was defined by decision making. In other words, is data considered "used" if review and discussion of analyzed data does not lead to a decision? There was also some inconsistency in language and measurement approach in considering if RHIS data use is inclusive or exclusive of data tasks such as data analysis, reporting, and data interpretation, though more authors considered these tasks to precede, and not be a part of, data use. Similarly, there was some disagreement about whether data review and discussion were a part of data use, but more authors viewed these to be a part of data use, along with problem identification, prioritization, decision making, action planning, action, and monitoring.

The refined PRISM-Act framework addresses these issues by clearly outlining the RHIS data tasks and which of these tasks, or steps, are a part of "data use." Separating RHIS data use into specific steps also highlights the role of RHIS data in each of these steps, when decision making

occurs, and that action is a necessary step for any improvements to health system performance. This approach also better accommodates the reality that data is only one part of successful decision making and action [18, 59], and the level of influence of the determinants of data use likely differ across each data use step.

Recommendations for improving data use measurement approaches

Based on the findings from this review, four key recommendations were identified to improve approaches to measuring RHIS data use: (1) clearly delineate RHIS data tasks, (2) use objective data collection approaches to measure RHIS data use, (3) select the appropriate data use outcome variable type, and (4) comprehensively report RHIS data use measurement approaches.

First, studies should clearly delineate RHIS data tasks and measure these activities separately. Many studies continue to include data analysis and data visualization activities in their measurement of data use, despite consensus that these activities precede, and are not a part of, data use. Use of the refined PRISM-Act framework should address this issue, by ensuring that each delineated RHIS data task, such as data processing and data analysis, are measured separately. A 2020 study from Ethiopia [19] made an important discovery when disaggregating data use into multiple steps and measuring each step separately. While a low proportion of health facilities reviewed their performance monthly (performance identification), an even lower proportion prepared action plans after reviewing performance (prioritization and action planning). Similarly, “mailbox syndrome” was observed in South Africa and Tanzania, where facility-level data were analyzed for reporting to higher levels, but not reviewed and discussed to inform facility-level decisions and actions [26, 27]. This highlights the importance of measuring data analysis, reporting, and data-informed decisions and actions separately, which will help

identify which RHIS data tasks are functioning well, and which require additional support. Endriyas et al.'s [19] approach to measuring data use steps can serve as a helpful resource for implementers and researchers.

Secondly, studies should aim to use more objective data collection methods such as observation and document review when collecting RHIS data use measurements. Many studies using the adapted version of the PRISM toolkit surveyed district and health facility staff to collect self-reported measures of data use, which are subject to social desirability and recall bias [46]. This adaptation diminishes the validity of the PRISM toolkit, which intentionally selected record observation as a gold standard data collection approach [15]. A study that measured data use through both self-reported and observed measures, found that participants reported higher levels of data use than what was observed through review of action plan implementation reports [19]. Endriyas [19], Prakash [55], and Wude [60] have used more objective measurement approaches and can serve as examples for future studies.

Third, the appropriate outcome variable type should be selected when conducting hypothesis testing and tests of association with data use as the outcome. Almost all studies testing the association of data use with potential determinants transformed a continuous data use variable into a binary "good" or "poor" data use variable, using the mean or median value as the cut-off. There are several disadvantages of dichotomizing a continuous outcome. First, substantial information is lost, such that the statistical power to detect an association between the outcome and predictor is reduced [61]. Dichotomizing a continuous variable at the median has been found to be equivalent to discarding a third of the data [61]. Additionally, using a cut-off to create a binary variable, such as "good" or "poor" data use oversimplifies the data. Data points near the cut-off are dichotomized to good or poor despite being very similar on the continuous scale,

which can lead to incorrect conclusions. Use of a cut-off has been shown to increase the risk of spuriously significant results by both overestimating the difference between groups and narrowing its confidence interval [61]. Instead, if data use is collected and calculated as a continuous variable, it is beneficial to maintain it as a continuous variable for tests of association. Binary measures of data use should only be used when the outcome is a specific, "yes, data was used in this event," such as whether a singular decision at a health facility was made based on RHIS data.

Lastly, studies measuring RHIS data use should comprehensively and clearly report their data use measurement approaches. This should include the type of data collection tool used (e.g., document review, questionnaire), a list of each item on the tool and its response options (e.g., yes/no; 5-point agreement Likert scale), and how the data use composite measure is calculated based on these items. If possible, a supplementary file of the data collection tool should be included. Dagnew [54], Endriyas [19], Odei-Lartey [62], Prakash [55], and Seid [63] are examples of studies comprehensively reporting their data use measurement approach. Clear reporting of methods will support researchers to advance RHIS data use measurement approaches.

Recommendations for future research

There remain several gaps in the literature on RHIS data use at the district and facility levels. Overall, there is a need for more quantitative studies to better understand the level and determinants of RHIS data use across different resource limited settings. Very little quantitative or qualitative exploration has been done to understand the level and determinants of data-informed decisions and actions, nor regarding the relationship between data-informed decisions and actions. In other words, what aspects of data-informed decisions successfully lead to action?

There is also a paucity of studies that report on actual decisions made and actions taken by health facilities based on RHIS data, as well as studies that have evaluated the impact of these decisions and actions on health system performance. This type of evidence is essential in informing the development of more effective RHIS data use interventions that support the translation of data into action.

Limitations

This review has some limitations. The literature search was limited to published peer-reviewed articles in English and thus is not representative of materials available in other languages and sources such as the grey literature. This may have narrowed the boundaries of the exploration of how RHIS data use is defined in the literature but aided in maintaining a level of methodological quality for the exploration of how RHIS data use is conceptualized and measured. The database searches were limited to four databases, but the high number of duplicate records identified through this search strategy and the relatively small number of articles identified from citation mining indicates the comprehensiveness of this review's search strategy.

Conclusion

This review fills a critical gap in the RHIS data use literature by developing a more refined definition and framework for RHIS data use and proposing improved approaches to measuring RHIS data use. Despite recognition of the critical importance of transforming data into action, RHIS data use interventions and studies have more often focused on RHIS activities such as data collection and analysis rather than on data-informed decisions and actions. The refined PRISM-Act framework illustrates that RHIS data use is a multi-step process that includes data-informed decisions and actions, and that it is in the implementation of actions that the performance of the

health system improves. Future studies exploring the determinants and relationships between these RHIS data use steps will help expand the evidence-base to inform the design of more targeted and effective RHIS strengthening strategies that ultimately lead to improved health system performance.

Appendices

Appendix A: Definitions reported by articles

Article	Country	Definition
Data use is defined by decisions and actions informed by data		
Abajebel 2011 [25] Bogale 2021 [56]	Ethiopia	"Using information for decision making to take immediate action."
Lazzerini 2019 [64]	Sri Lanka	"Any action-oriented recommendation generated from review of the data outcomes."
Lemma 2020 [31]	Synthesis	"Use of routine health information system data for decision making."
Leon 2020 [30]	Synthesis	"The capacity and processes for effective decision making"
Data use is defined by its application, i.e., the types of decisions made based on the data		
Hotchkiss 2012 [11]	Synthesis	"Decision makers explicitly considering information in policymaking, planning, management, and service delivery."
Nutley 2014 [22]	Côte d'Ivoire	"'Data-informed decision making' refers to the proactive and interactive processes that consider data during program monitoring, review, planning, and improvement; advocacy; and policy development and review."
Shiferaw 2017 [65]; Dagnew 2018 [54]; Wude 2020 [60]	Ethiopia	Use of routine health information to: • Monitor, manage, and improve day-to-day health service activities • Monitor and manage drug procurement and supply • Display and share updated information of key indicators • Predict, identify, and manage epidemics/outbreaks • Identify and prioritize community health problems • Mobilize the community • Mobilize and allocate resources • Check data quality • Evaluate department and staff performance
Rendell 2020 [34]	Synthesis	"The concept of leveraging data or findings from analyses of a set of indicators to improve health system performance."
Kumar 2021 [66]	Synthesis	"The analysis, synthesis, interpretation and review of data as part of decision-making processes such as program monitoring, policy development, and resource allocation." "'Data to action' refers to data-based decision making that shows a measurable impact of improvements in processes, systems, human resources, and institutional attributes."
Seid 2021 [63]	Ethiopia	"Use of health information in decision making, such as for planning, monitoring, evaluation, treating patients/services, disease prioritization, budget allocation, supervision, writing feedback, showing trends, and quality data reporting."
Tulu 2021 [58]	Ethiopia	"Using routine health information for service improvement, patient treatment, staff performance, planning, department evaluation, monitoring key performance indicators, prediction of outbreaks, resource allocation, development of policy and advocacy."
Data use is defined by its processes, i.e., the completion of specific tasks		
Aqil 2009 [15]	Synthesis	"Use of information for identifying problems, for considering or making decisions among alternatives, and for advocacy."
Nutley 2013 [23]	Synthesis	"The 'use' of data is the analysis, synthesis, interpretation, and review of data as part of a decision-making processes."
Endriyas 2020 [19]	Ethiopia	The process which encompasses, "problem identification, problem prioritization, preparing an action plan, monitoring implementation of action plan, data visualization, and assessing data quality."

Chanyalew 2021 [50]	Ethiopia	"The process that encompasses problem identification, prioritization, action plan development, implementation, and following-up, and providing regular feedback."
Osterman 2021 [29]	Synthesis	"A process in which data collected by the health system are converted into usable information through data processing, analysis, synthesis, interpretation, review, and discussion, then used to decide on a course of action."
Decision making definitions		
Wickremasinghe 2016 [18]	Synthesis	"The process by which a group of people reach a collective understanding of a topic, which then helps to build consensus on a particular course of action to address a health service challenge, from two or more possible options."
Bhattacharyya 2020 [67]	India	"Stakeholders reaching consensus on a particular course of action from two or more possible options to address health service challenges."
Tulu 2021 [58]	Ethiopia	"The process of identifying and choosing alternatives based on the values, preferences, and beliefs of the decision-maker."

Appendix B. Data use measurement approaches reported by articles

Country	Author, Year	Data collection tool	Data use items in tool (Response options Yes/No unless specified)	Data use measure
Ethiopia	Abajebel 2011 [25]	Study-designed questionnaire and observation tool	1. Received feedback from supervisor 2. Calculated area coverage and prepared maps 3. Presented key indicators with charts or tables 4. Presented achievement of targets	• Data use: Yes to 3-4 items • No data use: Yes to 0-2 items
Ethiopia	Shiferaw 2017 [65]	PRISM (adapted) questionnaire and observation tool	5-point agreement Likert scale applied to: 1. Uses data for day-to-day management of health service facilities and districts 2. Displays data for monitoring the key objectives of health services and showing key indicators by means of graphs and tables 3. Finds out whether the health professional can gather data to detect the cause of health problems to prioritize the problems and use the data for health education 4. Uses data to identify and manage epidemics 5. Uses data to observe trends of health services and for supply and management	• Good data use practice: Above the mean • Poor data use practice: Equal to or below the mean
Ethiopia	Dagnew 2018 [54]	PRISM (adapted) questionnaire and observation tool	• 13 items in questionnaire (5-point agreement Likert scale) • 8 items in observation tool	• Good data use: Above the mean • Poor data use: Equal to or below the mean
Ethiopia	Endriyas 2020 [19]	Study-designed document review tool (based on MEASURE 2009 [68])	1. Availability of performance review minutes 2. Minutes address high and low performance 3. Action plan indicates problem prioritization 4. Activities report indicate actions taken 5. Availability of up-to-date monitoring charts 6. Evidence of assessment of data quality	• Good data use: 75%+ • Fair data use: 50-74% • Poor data use: <50%
Ethiopia	Kebede 2020 [69]	PRISM (adapted) questionnaire	Not reported.	Binary; calculation method not reported.
Ethiopia	Wude 2020 [60]	PRISM (adapted) questionnaire and Federal Ministry of Health (adapted) document review tool	• 10 items in questionnaire (5-point frequency Likert scale) • 4 items in document review tool	Good/poor data use: cut-off not reported.
Ethiopia	Bogale 2021 [56]	PRISM (adapted) questionnaire and observation tool	Not reported in methods section. Reports the following in results section: 1. Monthly performance review meetings and monthly data analysis 2. Use data for decision making 3. Display achievement of target, population profile, and staffing by table or graph or chart in the service delivery unit	Not reported.

Ethiopia	Chanyalew 2021 [50]	PRISM (adapted) questionnaire	1. Presence of feedback from supervisor (response option not reported) 2. Evidence on the use of information for decision making (response option not reported)	• Good data use: Above the mean • Poor data use: Equal to or below the mean
Ethiopia	Gonete 2021 [57]	Document review tool (source not reported)	Not reported.	Not reported.
Ethiopia	Seid 2021 [63]	PRISM (adapted) questionnaire	Data used for: 1. Monitoring day-to-day activities 2. Treating patients/provide service 3. Prioritizing problem 4. Showing a key performance by the chart 5. Performance evaluation 6. Observing trends of service 7. Planning 8. Reporting of quality data 9. Taking action 10. Information dissemination	• Continuous % variable for descriptive analysis • Good data use: Mean score ≥65% • Poor data use: Mean score <65%
Ethiopia	Tulu 2021 [58]	PRISM (adapted) questionnaire	Data used for: 1. Service improvement 2. Patient treatment 3. Staff performance 4. Planning 5. Department evaluation 6. Monitoring key performance indicators 7. Prediction of outbreaks 8. Resource allocation 9. Development of policy 10. Advocacy	• Uses data: ≥5 yeses • Does not use data: ≤4 yeses
Tanzania	Nyamtema 2010 [27]	Study-designed questionnaire	Not reported. Tool available as appendix, appears to have one question: • For what purposes do consumers of data utilize the data: policy making, planning and budgeting, evaluation of health programs, other?	Does not report method to calculate overall data use measure. Reports % of "no" item responses.
Tanzania	Mboera 2021 [20]	Study-designed questionnaire and observation tool	Not reported.	Not reported.
Uganda	Hotchkiss 2010 [53]	PRISM (adapted) questionnaire and observation tool	2004 and 2007: 1. Display of a map, chart, or table based on RHIS data 2007 only: 2. RHIS information discussed in staff meetings 3. RHIS information used to make decisions 4. RHIS information used to take follow-up actions or refer for action 5. Display of a map, chart, or table based on RHIS data	• Use of RHIS information: Yes to item 1 (2004) • Continuous composite measure (2007)
South Africa	Kawonga 2013 [70]	Study-designed questionnaire	1. Reads HIV data report for own level	Binary; calculation

			2. Discusses HIV data with managers at own level 3. Discusses HIV data with managers at lower level/own facility staff 4. Discusses HIV data with managers at higher level 5. Interprets data: monitors against targets 6. Interprets data: compares to previous time periods 7. Makes decisions/takes action based on the data/indicator levels	method not reported.
South Africa	Nicol 2017 [26]	PRISM (adapted) document review tool	1. RHIS report production 2. Frequency of RHIS reports 3. Types of reports produced 4. Display of information at the facility-level 5. Use of information in available reports at facility 6. Types of decisions based on types of analyses 7. Discussion and decisions based on RHIS information 8. Promotion and supervision by the district office	Does not report method to calculate overall data use measure. Reports % of "yes" item responses.
Cote d'Ivoire	Nutley 2014 [22]	PRISM tool (adapted); specifics not reported	1. RHIS information was discussed in staff meetings 2. Decisions evolved from these discussions 3. Decisions were referred to upper management for action	Continuous composite measure (calculation specifics not reported).
Nigeria	Nwankwo 2018 [71]	Study-designed document review tool	Not reported.	Not reported.
Ghana	Odei-Lartey 2020 [62]	PRISM (adapted) document review tool	15 items in document review tool	Does not calculate overall data use measure. Reports % of "yes" item responses.
Cameroon	Nguefack-Tsague 2020 [72]	MEASURE Data Analysis, Dissemination, and Use tool [73]	18 items in document review tool (response options not reported)	Calculates and reports global RHIS performance score: • Good score: ≥60% • Poor score: <60%
Cameroon	Tamfon 2020 [74]	MEASURE Data Analysis, Dissemination, and Use tool [73]	18 items in document review tool with response options: 0 = no answer/not applicable 1 = not present, needs to be developed 2 = needs a lot of strengthening 3 = needs some strengthening 4 = already present, no action needed	Does not report method to calculate overall data use measure. Reports % of select response items.

India	Prakash 2021 [55]	Study-designed decision tracking system	1. Number of decisions taken 2. Number of actions completed	Frequency calculated for a continuous data use scale.
Pakistan	Nawaz 2020 [75]	PRISM (adapted) questionnaire	33 items in questionnaire	Does not calculate overall data use measure. Reports % of response items.
Pakistan	Kumar R 2012 [76]	Study-designed questionnaire	Not reported.	Not calculated.

Chapter 3. Determinants of translating routine health information system data into action in Mozambique: A qualitative study

Abstract

Introduction Routine health information systems (RHISs) are an essential source of data to inform decisions and actions around health facility performance, but RHIS data use is often limited in low- and middle-income country contexts. Determinants that influence RHIS data-informed decisions and actions are not well understood, and few studies have explored the relationship between RHIS data-informed decisions and actions.

Methods This qualitative study explored the determinants and characteristics of successful RHIS data-informed actions at the health facility level in Mozambique and which determinants were influenced by the Integrated District Evidence to Action (IDEAs) strategy. Two rounds of qualitative data were collected in 2019 and 2020 through in-depth interviews and focus group discussions with provincial, district, and health facility-level managers and frontline health workers who participated in the IDEAs enhanced audit and feedback strategy. The Performance of Routine Information System Management – Act (PRISM-Act) framework guided the development of the data collection tools and thematic analysis.

Results Key behavioral determinants of translating RHIS data into action included health worker understanding and awareness of health facility performance indicators coupled with health worker sense of ownership and responsibility to improve health facility performance. Supervision, technical support, and availability of financial and human resources were highlighted as essential organizational determinants in the development and implementation of action plans. The forum to regularly meet as a group to review, discuss, and monitor health facility performance was emphasized as a critical determinant by study participants. Shortage of

nurses together with the need to prioritize patient care were barriers to translating RHIS data into action.

Conclusion This study fills a critical gap in the RHIS data use literature by examining the determinants of successful data-informed actions at the health facility level and underscores the need to investigate determinants by distinct RHIS activities.

Introduction

All people should have access to the health services they need, when and where they need it, without financial hardship. This is the promise of universal health coverage, which can only be achieved through improved health system performance. At the foundation of a well-functioning health system is a strong health information system that informs decisions and actions regarding health system financing, leadership and governance, health workforce, service delivery, and essential medicines [9].

With widespread implementation of health system decentralization in low- and middle-income countries (LMICs) including Mozambique [77-80], decision making responsibilities such as health service delivery planning and management has shifted to districts and health facilities [18, 77, 78, 80, 81]. Routine health information system (RHIS) data are routinely generated at the health facility and are an important source of information regarding health facility performance [10, 17, 82]. RHIS data-informed decision making, a process by which a group reviews analyzed RHIS data to reach a decision about priorities and action steps [35], is limited in LMICs [18, 21, 22]. Even when decisions are made based on RHIS data, decisions often do not lead to action [19, 28, 29], which is what is ultimately needed to improve health system performance and population health.

Despite this, determinants that influence RHIS data-informed decisions and actions are not well understood, and few studies have explored the relationship between RHIS data-informed decisions and actions [11, 30-35]. Relatedly, most RHIS data use interventions focus on technological enhancements and health workforce training to increase data availability and improve data analysis capacity, but do not address this known gap to move beyond data analysis to increase data-informed decisions and actions [10, 28, 30, 31].

The Integrated District Evidence to Action (IDEAs) strategy aimed to improve RHIS and health system performance by supporting district and health facility staff to make data-informed decisions and implement actions that are low-cost and contextually appropriate. IDEAs united provincial, district, and health facility managers to regularly analyze, synthesize, and discuss health facility performance using RHIS data. Discussions included identification of priority issues and barriers to adhering to evidence-based guidelines, as well as the development and monitoring of action plans.

The aim of this study was to explore the determinants of successful data-informed actions at the health facility level in Mozambique and how the IDEAs strategy influenced those determinants. Of particular interest was to understand the characteristics of data-informed decisions that successfully led to data-informed actions. This information is critical in expanding the evidence-base of strategies that support translation of RHIS data into action, which is vital in improving health system performance to achieve universal health coverage.

Methods

Study design

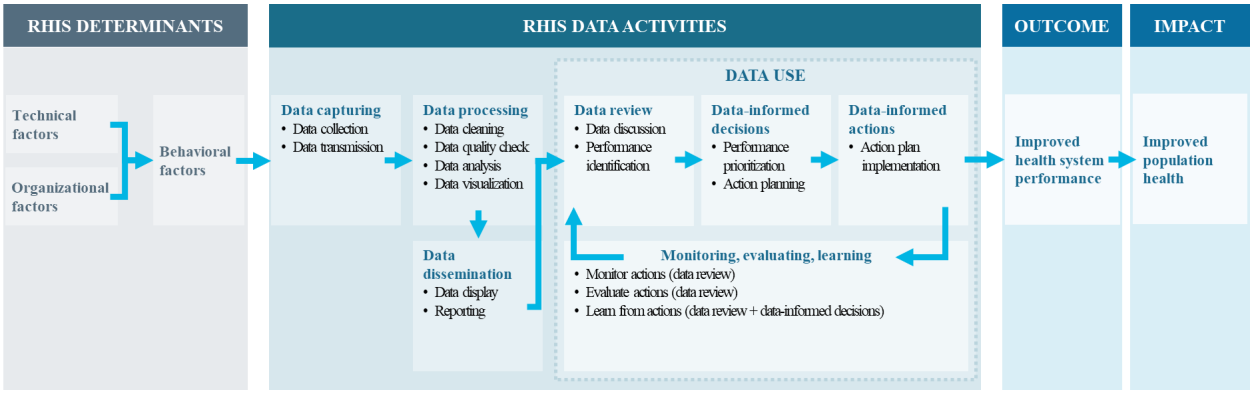
This qualitative study, embedded in a quasi-experimental trial evaluating the impact of the IDEAs strategy, explored the determinants and characteristics of data-informed decisions that

successfully led to action, and which determinants the IDEAs strategy influenced. Two rounds of data collection through in-depth interviews (IDIs), and focus group discussions (FGDs) were coded and analyzed for themes guided by the refined Performance of Routine Information System Management (PRISM) framework, the PRISM-Act framework [35].

Definition and conceptual framework

RHIS data use was defined as the process by which health staff review analyzed RHIS data to identify, address, and monitor performance gaps and priorities [35]. The PRISM-Act framework (Figure 1) [35] served as the conceptual framework for this study, as it illustrates that RHIS data use at the health facility and district, or equivalent administrative level, is a multi-step process in which data-informed decisions precede data-informed actions. The framework also illustrates that data-informed actions are the critical last step in the RHIS data use process that contributes to improvements in health system performance.

Figure 1. Performance of Routine Information System Management (PRISM) - Act framework



RHIS data use activities are influenced by technical, organizational, and behavioral determinants, as defined by the original PRISM framework [15]. Technical determinants are factors that relate to the RHIS design itself, such as the indicators collected, data collection forms, and technology used to store and exchange the data. Organizational determinants include all factors that are related to the organizational context, such as the organizational hierarchy,

resources, and its policies and procedures. The behavioral determinants, which are influenced by technical and organizational determinants, include all factors related to the individual, such as their level of knowledge, skills, and motivation to conduct RHIS activities.

Intervention

The IDEAs strategy aimed to improve RHIS and health system performance to improve services for women, newborns, and children, by supporting district and health facility managers to make data-informed decisions and implement evidence-based actions that are low-cost and align with organizational priorities. The IDEAs strategy was an iterative three step process of 1) a health system readiness assessment, 2) semi-annual, five-day district performance review and enhancement meetings, and 3) targeted facility support. The review meetings were held for each intervention district, uniting facility managers with district and provincial managers to analyze, visualize, and present RHIS data comparing achieved versus desired health facility performance for maternal, newborn, and child health services. Presentation of data was followed by group discussion to identify service gaps and support the development or updating of health facility action plans to improve service delivery. The highest performing and two lowest performing facilities, determined based on maternal, newborn, and child health indicators, were then selected to received targeted support, which included site visits by provincial and district managers along with the IDEAs team.

Setting

IDEAs was implemented from 2016 to 2021 in all 151 primary health facilities providing full maternity and child health services in 12 selected districts in Manica and Sofala provinces in central Mozambique. Intervention districts were purposively selected based on large population size, a robust health facility network, and geographic accessibility.

Mozambique's national healthcare system includes three interconnected and interdependent sub-systems: 1) the public sub-system, corresponding to the National Health Service, 2) the community sub-system, and 3) the private sub system [83]. The National Health Service is organized in four levels, with the primary level delivering the primary healthcare package and the quaternary delivering specialized services [84]. At the national-level, the Ministry of Health is responsible for health policy development and program coordination, including drug acquisition and distribution and oversight of the health information system [80, 81]. Two province-level entities, the Provincial Health Service and the Provincial Health Directorate, are responsible for carrying out the policies of the Ministry of Health. The Provincial Health Directorate is also responsible for overseeing primary health services. District-level Health Directorates coordinate all district health activities, including oversight of the primary care facilities.

Study participants

Round 1 (2019)

Purposive sampling, based on provincial representativeness and geographic accessibility, was used to select districts from which key informants were invited for IDI and FGDs. Critical case sampling was used to invite participants for IDIs and FGDs; a case was identified as critical based on their role as data collector, data user, and/or decision maker at the district or health facility-level. Cases were also invited based on their length of participation in IDEAs and attendance of at least one performance review meeting. At the district-level, two district health managers from each of the four selected intervention districts were invited to participate in IDIs. At the facility-level, 10 frontline nurses from each of the selected intervention districts were invited to participate in FGDs.

Round 2 (2020)

Purposive maximum variation sampling was used to select districts and health facilities from which key informants were invited for IDIs and FGDs. Health facilities were selected based on their performance on key indicators at the prior performance review meeting; the highest performing and two lowest performing health facilities per district were selected to capture a diversity of perspectives, experiences, and approaches. Purposive critical case sampling was used to invite key informants for IDIs; a case was identified as critical based on their role as data collector, data user, and/or decision-maker at the provincial, district, or health facility-level and their participation in IDEAs. All frontline nurses who attended the November 2020 performance review meeting were invited to participate in the FGDs.

Data collection

Round 1 data collection occurred in November and December 2019; Round 2 data collection occurred in October and November 2020. The second round built on learnings from the first round to investigate the decision-making process more deeply and how the decision-making process itself may impact successful implementation of decisions. IDIs and FGDs were conducted in Portuguese by a skilled facilitator using a semi-structured guide (Appendix A: Interview guide), assisted by a note taker. Key informants were asked how data were being used, from the point of collecting the RHIS data, to analysis, review, discussion, decision, action, and monitoring. The IDI and FGD guide also included questions about what aspects of the IDEAs strategy promoted or hindered decisions and actions. A study assistant took detailed notes during all IDIs and FGDs and descriptions were further expanded during daily debrief meetings. When consent to audio record was provided, IDIs and FGDs were audio recorded. Audio recordings were transcribed word-for-word into Microsoft Word and then translated to English.

Data analysis

An a priori codebook guided by the PRISM-Act framework was applied to the qualitative IDI and FGD data using ATLAS.ti (v8). Coding was an iterative process, with initial coding informing the development of a refined codebook and further refined until a final codebook was developed. Codes were reviewed by the research team and any changes or disagreements were discussed until resolved. Once coding was finalized, codes were grouped into themes guided by the PRISM-Act framework. Exemplary quotations were identified to represent the themes. Themes and quotations were then stratified by whether the quotation source worked at a district or health facility with high, mid, or low action plan implementation rates to assess if there were differences in themes based on rate of successfully implementing planned actions. Implementation rates were calculated based on available program data on the number of planned actions implemented divided by the number of actions planned. Facilities implementing 50% or fewer planned actions were categorized as "low," 51-75% as "mid," and 76-100% as "high."

Ethical considerations

This study was approved by the institutional review boards of the Ministry of Health (#IRB00002657) and the University of Washington (#STUDY00003926). IDIs and FGDs were conducted after obtaining written informed consent from participants. Study data were stored in password-protected files that were only available to study staff for the purpose of data analysis.

Results

A total of 97 participants, comprising 2 provincial-level managers, 15 district-level managers (district directors, chief medical officers, program supervisors), and 80 facility-level staff (frontline nurses) participated across 28 interviews and 7 FGDs in 2019 and 2020 (Table 1).

Table 1. Study participants by health system level and role, 2019 and 2020

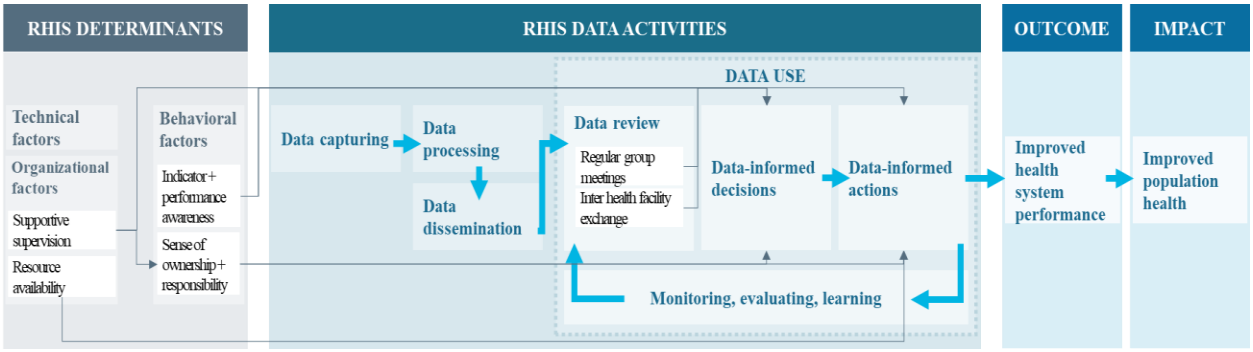
	2019	2020	TOTAL
Provincial managers	0	2	2
District managers	7	8	15
Health facility nurses	39	41	80
TOTAL	**46**	**51**	**97**

Many intervention participants expressed how the forum to regularly meet as a group to review, discuss, and monitor health facility performance was crucial in translating data into action. Supervision and technical support as well as availability of financial resources were noted as essential elements to developing and implementing action plans. Participants did not mention technical determinants. Table 2 summarizes the key facilitators and challenges participants experienced in translating RHIS data into action. Figure 2 illustrates the relationship between the determinants and data-informed decisions and actions.

Table 2. Facilitators and challenges to translating RHIS data into action at the facility-level, Mozambique

	Facilitators	Challenges
Behavioral	• Health worker understanding of key performance indicators and increased awareness of health facility performance • Health worker sense of ownership and responsibility	--
Organizational	• Supervision to create accountability and provide support • Availability of financial resources	• Limited availability of human, financial, and material resources
Technical	--	--
Characteristic of data review process	• Forum to regularly meet, review, discuss, monitor, adjust as a group • Forum to compare and learn from other health facilities	--

Figure 2. PRISM-Act framework with determinants of data-informed decisions and actions



Behavioral determinants

Indicator and performance awareness

Several intervention participants, primarily from facilities and districts with high action implementation rates, explained that the IDEAs strategy supported participants to grasp which indicators are collected and how these indicators link directly to clinical practice. As one participant explained:

> *"**IDEAs helps us to know the indicators and its purpose**. The intervention opened up our eyes. Before the intervention, we thought, 'What is the purpose of that? What is the purpose of prenatal consultation?' But with the intervention, I understand the main indicators, what I have to notice, and where we are failing. **We know the indicators better and implement them fully**."*
>
> – District manager, high action district

The intervention also improved health worker skills in monitoring and evaluating health facility indicators, leading to an increased awareness of their own health facility's performance. This increased awareness of health facility performance and the recognition that their own practice directly affected these indicators, were catalysts for health workers to change their practice. This change was noted by participants across all action implementation rates (low, mid, and high):

> *"Reviewing the data and having a person have **hyper awareness of certain indicators helps to improve performance**, just by the awareness alone."*
>
> – District manager, low action district

> *"It helped us a lot… evaluating to see that, here I have to do something to improve my data. Not here, something is failing, **I have to rectify it**."*
>
> – Nurse, high action facility

Sense of ownership and responsibility

Ownership and a sense of responsibility for the action planning and implementation process were critical in motivating health workers to implement their action plans. One nurse from a

health facility with a high action implementation rate explained their role in the action planning process:

> *"**Who makes the decision, is us. It's us.** We sat down and reached consensus that this is what we have to do, this we don't. How we design the plan, how it should be, how we should work this."*
>
> – Nurse, high action facility

This responsibility to develop, implement, and monitor action plans increased nurse motivation to improve health facility performance:

> "*The **health facility is responsible** for analyzing the data and decision making, which **increases likelihood of implementation**."*
>
> – Nurse, mid action facility
>
> *"The action plan drawn up in the meetings are the **responsibility of the nurse** and not the district as it was before. **This makes the nurse work harder to do better**."*
>
> – Nurse, mid action facility

Organizational determinants

Supportive supervision

District supervisory visits contributed to creating a culture of accountability, which, as described previously, was a strong motivator for health workers to implement and monitor health facility action plans. District managers described using both the performance review meetings and supervisory visits to create this culture of accountability, while health workers described feeling motivated by the supervisory visits:

> *"Some colleagues are more dedicated and responsible, and others do not care about the results. But **we are fighting to make everyone take responsibility** for what they produce."*
>
> – District manager, mixed action district
>
> *"From the supervisory visits, we have learned a lot. There are even some moments that we ended up relaxing more, right? So when they see you, **they encourage you a lot**."*
>
> – Nurse, high action facility

District supervisory visits were also important in providing in-person, on-the-job technical support to health facilities. One nurse at a facility with high action implementation rates described the hands-on, collaborative process that took place during supervisory visits:

> *"We work together. Not that they just come to explain to us,* ***but they come and work with us.****"*
>
> – Nurse, high action facility

A district director added that this in-person support led to improved health facility performance:

> *"When the supervision team arrives and is in the health facility to do more* ***on-the-job training, then the results are better****… so these inputs, I would call them facilitators, make it more possible [for the health facility] to achieve the objectives."*
>
> – Provincial manager

Availability of human, financial, and material resources

Another common theme was that the availability of financial resources were necessary components to successful action plan implementation. Many participants commented on how fundamental it was that the IDEAs strategy supported the purchase of materials and equipment to enable implementation of action plans, ultimately leading to improved services and health facility performance. Conversely, some participants expressed that the lack of available materials was a barrier to implementing action plans and improving health services. Participants also commented on the shortage of nurses and the need to prioritize patient care as barriers to dedicating time to data collection, data review, and data-informed decisions and actions:

> *"A colleague at the health facility that is working alone, who has many activities to do and cannot manage everything they should be doing… The [time for]* ***data review will be little because of the overload of their work****."*
>
> – District manager, mid action district

Characteristic of data review process

Forum to regularly meet, review, discuss, monitor, and adjust as a group

Participants, especially those from facilities with high action implementation rates, emphasized the critical importance of having the forum to regularly sit as a group to review and

discuss RHIS data in monitoring health facility performance and in developing, implementing, and adjusting action plans. Participants explained that while data collection, analysis, and report development were necessary preceding steps to make data-informed decisions, the process to sit, review, and discuss the analyzed data was the essential element for decision-making and problem solving:

> *"For decision making, we first sit down with the top managers. We [the frontline nurses] show the data to see how things are going. Based on this analysis, we make a decision.* ***For decision making, you must first sit down*** *to study the case."*
>
> – Nurse, high action facility

> *"****I don't work alone, it's a team effort****, right? There is help from other colleagues, the leaders also contribute a lot. I'm talking about my facility director, my intervention team, they support a lot…* ***so we sit down and talk*** *and are able to evaluate the information."*
>
> – Nurse, high action facility

In addition to the importance of creating the time and space to review and discuss analyzed data, it was especially crucial to have this process occur as a group, with the involvement of facility leaders, to ensure decisions led to action:

> *"When we make a decision, we have to take into account the logistics, the material, the availability of transportation…* ***I can make a decision, but without support****,* ***without the teams****, adequate equipment,* ***I can hardly do anything****. So there has to be a support team there to reach a final decision."*
>
> – Nurse, high action facility
>
> *"Interviewer: What factors help to successfully implement the action plan? Interviewee: It is just a matter of* ***involving the leaders****."*
>
> – Nurse, high action facility

Meeting frequency was also noted to be an important part of prompting action plan implementation and monitoring, as well as in adjusting action plans to be more effective in improving service delivery:

> *"****We review the data and action plan monthly****. And if we have a very low finding in the monthly summary and we have not done the action plan, we work to achieve it because* ***we have to have the action plan fulfilled****."*
>
> – Nurse, high action facility

"We talk about weekly goals. ***If we work on the week, we no longer have problems*** *at the end of the month."*

– District manager, mixed action district

Forum to compare and learn from other health facilities

While the previous theme highlighted the importance of intra-health facility performance review and discussion, participants also noted the importance of inter-health facility dialogue for problem solving and promoting action plan implementation. Participants explained that the performance review meetings with other health facilities enabled them to learn from the experience of other facilities, especially in borrowing action plan ideas that had already been tested elsewhere and been proven successful:

*"****We gain experience from other health facilities****, because in the performance review meetings we ask, 'colleague, how did you manage to reach that goal?' So from there, we are trying to* ***take advantage of the ideas*** *of other health facilities and there it helps us to change. The project itself* ***creates conditions for us to change*** *because of these meetings."*

–Nurse, high action facility

"When we bring all the health facilities to the same table, each one presenting its performance, there is an exchange of impressions, there is an exchange of experiences. There is an interconnection between the health facilities themselves, ***the one that has the same problem that the other managed to overcome****… and in the next period, we can see the other has already improved."*

– Provincial manager

Additionally, the inter-health facility exchanges motivated health facility staff to implement planned actions to improve facility performance:

"There is this ***effort of not to be left behind****… so if one day a health facility presented its weaknesses, it is even embarrassing for the health facility itself if it presents that weakness again, and* ***they end up feeling moved to act****."*

– Provincial manager

Discussion

The aim of this study was to explore the determinants of RHIS data-informed actions at the health facility level, with special attention to the relationship between data-informed decisions

and actions, and which determinants were influenced by the IDEAs strategy. Participants discussed organizational and behavioral determinants of data-informed decisions and actions; technical determinants were not mentioned, likely because IDEAs focused on influencing behavioral and organizational determinants rather than technical determinants. Characteristics of performance review meetings were noted to be a crucial determinant of translating data into action. More facilitators than challenges to acting on data-informed decisions were mentioned by participants.

Behavioral determinants

The importance of health worker sense of ownership and responsibility in developing, implementing, and monitoring action plans as a determinant of RHIS data-informed actions has not been a common theme in the literature. A few studies have noted that the "decision space," whereby local officials may or may not have the authority to make decisions, especially related to mobilization and allocation of resources, influence RHIS data-informed decisions [11, 18, 85]. Studies have also found that the lack of clarity about who is responsible for RHIS activities can be a barrier to RHIS data use [85, 86]; therefore, clear expectations of RHIS data use responsibilities among IDEAs participants may have contributed to the successful translation of data into action.

The infrequency of this determinant in the literature may not be reflective of its importance or commonality in affecting data-informed actions, but a reflection of what interventions are implemented and how they are studied. That is, sense of ownership and responsibility may not be as influential of a factor for RHIS data analysis and reporting, which are the focus of much of the RHIS data use literature [29, 35]. Relatedly, the two behavioral determinants of data-informed actions identified in this study, indicator and performance awareness and sense of ownership and

responsibility, are not behavioral determinants in the original PRISM framework, in which "RHIS data use" is a general, broad concept. This suggests that each step of the RHIS data use process may have differing determinants, and interventions and evaluations could benefit from considering these differences.

Organizational determinants and characteristics of performance review meetings

The strongest theme across interview and FGD transcripts was how the forum to regularly meet as a group to review, discuss, and monitor health facility performance was critical in translating data into action. This is a key finding in that while the organizational context affects whether meetings are held and who participates, it is the characteristic of the performance review process that influences whether RHIS data-informed decisions are made and successfully implemented.

While the district-wide IDEAs performance review meetings occurred every six months, nurses working at facilities with high action plan implementation rates emphasized the importance of meeting weekly or monthly as a facility, alongside facility leadership, to monitor and adjust action plans. This regularity of meeting frequency was perceived to encourage implementation of planned actions and support development of effective action plans that improved health facility performance. The importance of meeting frequency in promoting RHIS data use was identified by a 2020 systematic review on data use factors in LMICs [34], though this evidence was found only in the grey literature and not in peer-reviewed publications. The importance of supportive health facility leadership aligns with other studies that have highlighted the importance of actively involved local leaders, such as district and health facility managers, in promoting RHIS activities [34, 55, 60, 65, 69, 87-90].

Meeting frequency and leadership participation at the health facility-level, may explain some of the differences in action plan implementation rates across IDEAs intervention facilities. Increasing meeting frequency and facility leadership participation at facilities with lower action plan implementation rates may improve action plan implementation rates. Further investigation of factors that influence health facility performance review meeting frequency, optimal meeting frequency, and factors health facilities should consider when determining meeting frequency will be informative in designing more targeted and effective RHIS data use interventions in the future.

The shortages of health workers, particularly nurses, and its barrier to RHIS data use is well-established. Staff shortages at health facilities mean high workloads, with little time for tasks beyond the delivery of health services [10, 21, 26, 27, 85, 91, 92]. A qualitative study from Pakistan described the negative cycle whereby health workers do not enter data because of lack of time, motivation, and perception of value and then because they do not receive feedback for this behavior, their motivation and perception of value of collecting data diminishes further [85]. This indicates that audit and feedback and supportive supervision may help mediate some of the negative effects of the health worker shortage on RHIS data use, but without addressing this widespread system challenge in LMICs, RHIS data use cannot be optimized.

Strengths and limitations

This study helps fill a major gap in the RHIS data use literature by examining the determinants of translating RHIS data into action, focusing specifically on the relationship between data-informed decisions and actions. This relationship has rarely been investigated in the literature; Wickremasinghe et al., in their systematic review of district-level decision making found an absence of studies that investigated whether decisions actually led to change in practice

[18]. Similarly, Rendell et al., in their systematic review of factors that influence RHIS data use noted the paucity of studies that investigate the relationship between data-informed decisions and actions [34]. Instead, most RHIS data use studies and interventions focus more broadly on RHIS activities such as data collection, data analysis, and data review, without specifically examining and addressing promoters and barriers to data-informed decisions and actions [34, 35].

Common determinants identified through this broad examination of "RHIS data use" include accessibility and timeliness of RHIS data [22, 26, 31, 85, 90, 92]; in other words, if data is unavailable to analyze and review, it cannot be used to inform decisions and actions. However, while data availability influences whether data is available to analyze, there is no indication from the literature or this study that data availability influences whether a decision, based on available and analyzed data, leads to action. Similarly, many RHIS data use interventions focus on improving the data collection and analysis skills of health workers [10, 31], which are necessary pre-requisites to making decisions and taking action informed by RHIS data, but insufficient to promote data-informed action [17]. In contrast, several of the determinants identified through this study, health worker awareness of health facility performance and linkage to their clinical practice, sense of ownership, responsibility, and the "decision space" to improve health facility performance, and the forum to meet regularly as a group, were found to be important facilitators to translating data into action but have rarely or never been described in the RHIS data use literature.

This highlights the importance of clearly delineating RHIS activities such as data-informed decisions and actions when investigating the determinants of RHIS activities, as is presented in the PRISM-Act framework [35]. This delineation allows precise diagnosis of the facilitators and barriers health facilities face in translating data into action at every step of the RHIS data use

process, enabling the development of more targeted, effective interventions to promote RHIS data use. This is critical, given that a persistent challenge in the RHIS data use field is the low rate of data-informed decision making in LMICs and that decisions often do not lead to action [19, 28, 29].

Study findings also suggest that the IDEAs strategy was successful in influencing key behavioral and organizational determinants in the translation of data to decision-making and action. This is notable, given the paucity of RHIS data use interventions that influence organizational determinants [10, 31] or strengthen the link between data analysis, data-informed decisions, and data-informed actions [18, 28, 29, 35].

There are limitations to this study. First, care should be taken when generalizing these findings to settings beyond the intervention districts and facilities. While maximum variation sampling was used to select intervention health facilities to capture the experience of participants working in diverse settings, it is not representative of all health facilities and districts in Mozambique. Second, while the study sought to understand the determinants of RHIS data-informed actions, its findings were not comprehensive and may have been limited to determinants influenced by the IDEAs strategy. More studies are needed to build on findings from this novel investigation, to build a more complete understanding of the determinants of each step of the RHIS data use process.

Conclusion

This study fills a crucial gap in the RHIS data use literature by examining the determinants of successful data-informed actions at the health facility level and identifying the key determinants of the IDEAs strategy that influenced the translation of RHIS data into action in Mozambique. Findings validated the need to investigate RHIS activities across their multi-component steps,

given that the determinants of earlier RHIS activities such as data analysis differ from those that influence data-informed decisions and actions. Learnings from this study contributes to informing the development and implementation of more effective, targeted RHIS data use interventions that promote data-informed actions, the last and most critical step in transforming health systems.

Appendices

Appendix A: Interview guide

Note: Blue text indicates text related to data-informed decisions and actions

Introduction: Thank you so much for taking the time to speak with me today. As we discussed during the informed consent process, we asked for this interview to better understand from you how the strategy that HAI and MISAU are supporting is working to improve the performance of maternal and child health services at the health facility where you work. During the interview I will ask you to focus on the components of the strategy, which are: assessing the readiness of the district and health facilities; data quality assessment; performance review meetings; technical supervision; and financial support to selected health facilities during performance review meetings. We also ask you to think about the aspects that facilitate or hinder the success of the strategy and what can still be done to improve the strategy. I will ask you to please focus on what has happened since January 2019 until now, October/November 2020.

1. Identification
    a. What is your position at the health facility?
    b. What are your responsibilities associated with this position?
    c. What has been your relationship and role with the IDEAs strategy? For how long?
2. Characteristics of the strategy
    a. In your opinion, why is the strategy being implemented?
    b. What advantages do you see with the strategy, compared to other strategies or programs to achieve the same objective of improving maternal and child health at your health facility?
    c. How do components of this strategy compare to the components of other strategies or programs that aim to achieve the same objectives at your health facility?
3. Implementation process
    a. In your opinion, is the strategy being implemented as planned?
    b. Is the strategy being implemented using appropriate methods and procedures?

c. Is the strategy being implemented involving adequate and properly prepared personnel?

d. Please describe the decision-making process for developing the action plans. How do you decide what actions to implement?

i. What factors help the team to make decisions? [Prompt, if needed: For example, a clear understanding of the problem, the manager is a good facilitator, everyone agrees, etc.]

ii. What factors can make it hard for the team to make decisions?

4. Link between components

a. Could you please describe how each component of the strategy is working in your health facility?

i. Do you feel that the components work well?

ii. What issues exist or existed?

iii. What changes have been made?

b. Could you please describe how the components work together?

5. Internal context of the strategy

a. What aspects of the organization and functioning of your health facility support the implementation of the strategy?

i. What aspects has helped you to successfully implement planning actions?

ii. What aspects of the decision-making process promoted successful implementation of planned actions?

b. What aspects facilitate the adaptation of the strategy to the management and work systems and methods of your health facility?

c. What aspects have hindered the implementation of the strategy?

i. What aspects have hindered the implementation of planned actions?

ii. Was there anything you would have differently in the performance review meetings that would have improved the chance of successful implementation?

d. What aspects make it difficult to adapt the strategy?

6. Priority

a. How high of a priority do you think the strategy is for your health facility?

b. For which sectors or people is the implementation of the strategy seen as a priority?

c. For which sectors or people does the implementation of the strategy not seem to be a priority?

[Ask if time allows]

7. Individual identification with the strategy

    a. How well do you feel you know the strategy?

    b. How likely do you think the strategy has a chance of succeeding?

    c. What has been your level of training, capacity, motivation, and experience, relative to what was expected of you to implement this strategy?

8. External context of the strategy

    a. Does the health facility where you work receive any support or pressure to implement this strategy?

    b. Does this support or pressure help you or make it more difficult for you to implement the strategy?

    c. Does the health facility where you work put positive or negative pressure on SDSMAS or other organizations and institutions to ensure the implementation of this strategy?

Chapter 4. Organizational factors associated with translating routine health information system data into action in Mozambique: Longitudinal analyses from 2017-2020

Abstract

Introduction Use of routine health information system (RHIS) data to inform improvements in health facility performance is an essential approach to achieving universal health coverage, but RHIS data use remains limited in many low- and middle-income countries and little evidence exists regarding factors that promote or hinder use of RHIS for improving health facility performance. The objectives of this study were to assess patterns of translating RHIS data into action among health facilities in Mozambique and explore the organizational factors associated with successful translation of RHIS data into action.

Methods Data comes from a sample of 36 facilities in Mozambique that participated in a data-to-action strategy from 2016 to 2020. The strategy united provincial, district, and facility staff at semi-annual meetings where staff analyzed and reviewed RHIS data to inform the development of facility action plans to improve maternal, newborn, and child health services. Data includes number of actions planned and implemented and facility characteristics such as staff size, management practices, and RHIS data completeness. Generalized mixed effects logistic regression was used to identify factors associated with successful implementation of planned actions informed by RHIS data.

Results From 2016 to 2020, participating facilities implemented a total of 1567 of 2462 planned actions (64%). Facilities planned an average of nine actions during each semi-annual performance review meeting, with the highest number planned during the first meeting and plateauing at an average of five actions per meeting. The number of actions planned was significantly associated with the likelihood of implementing a planned action, with the likelihood

increasing by 2% for every additional action planned (aOR: 1.02, CI: 1.01, 1.03). Facilities where staff cited limited staff availability as the top barrier to facility performance were significantly less likely to implement planned actions compared to facilities where it was not cited as a top barrier (aOR: 0.52, CI: 0.36, 0.75), as were facilities where staff cited limited financial resources as the top barrier (aOR: 0.42, CI: 0.23, 0.76).

Conclusion Findings from this study indicate that strategies that support health facilities to develop action plans informed by RHIS data may promote increased implementation of actions to improve facility performance. Investments in addressing health workforce shortage issues may contribute to increased use of RHIS data to inform improvements to health facility performance.

Introduction

Substantial progress has been made in reducing maternal, newborn, and child deaths in recent years [93], but women and newborns continue to die every year from preventable complications before, during, and after childbirth. Over 800 women are estimated to die every day from preventable causes related to pregnancy and childbirth [94, 95], and in 2019 alone, over five million children died from mostly preventable and treatable causes before reaching their fifth birthday [96, 97]. Furthermore, global inequities persist, with most of these deaths occurring in low-resource settings [93, 95, 96]. To address this global crisis, the World Health Organization has called on countries to use innovative approaches to ensure universal health coverage so that all people have access to quality health services without financial hardship [94, 96].

Investments to improve the quality and use of routine health information system (RHIS) data has been recognized as a critical element to improving health system performance in lower and middle-income countries (LMICs) and in achieving universal health coverage [6-8]. This aligns with the World Health Organization's framework for health systems strengthening, which points

to the foundational role of the health information system in informing data-driven decisions and actions in the other health system building blocks: financing, leadership and governance, health workforce, service delivery, and essential medicines [9].

RHISs are characterized by systems that ensure the production, analysis, and use of data at intervals of less than a year to inform health system management activities such as planning, resource allocation, and continuous quality improvement [10, 12]. In the context of widespread health system decentralization in LMICs and decision-making responsibilities shifting to health facilities, health facilities increasingly rely on RHIS data to inform quality improvement cycles to address facility-level performance gaps [8, 77-79].

However, RHIS data use remains low in LMICs [18, 21, 22]. While large amounts of RHIS data is collected, the data is often not analyzed [8, 10, 18-24] due to a lack of trust in the data quality and limited human resource availability and capacity to effectively analyze and synthesize the data [8, 10, 11, 18-24, 91, 98, 99]. Even when RHIS data are analyzed and reviewed to inform health facility improvement plans, the plans are often not implemented [19, 28, 29], inhibiting improvements to health system performance and population health.

Though the organizational context, which includes the organizational processes and structures such as the organizational culture, management and supervision structures, and availability of resources, are the most commonly reported barriers to improving RHIS data use [10, 30], RHIS strengthening interventions that address organizational factors are rare [31]. Several studies in Ethiopia found that supportive supervision, performance evaluations, and regular feedback were organizational factors associated with RHIS data use [50, 54, 60, 63, 65], but RHIS data use interventions more commonly focus on technical determinants related to the RHIS design itself such as the technology used to store and exchange data or the behavioral

determinants, with special focus on strengthening health worker skills in data analysis [10, 30, 31]. Relatedly, few RHIS strengthening interventions and studies focus on the final and critical step of translating RHIS data into action and little is known regarding organizational factors associated with translating RHIS data into action [28, 35].

This study aimed to address these gaps in the literature by: (1) understanding the patterns of RHIS data-informed plans and actions among health facilities participating in a data-to-action strategy to improve maternal, newborn, and child health (MNCH) services in Mozambique and (2) exploring what organizational factors are associated with successfully implementing RHIS data-informed actions.

Methods

Study design

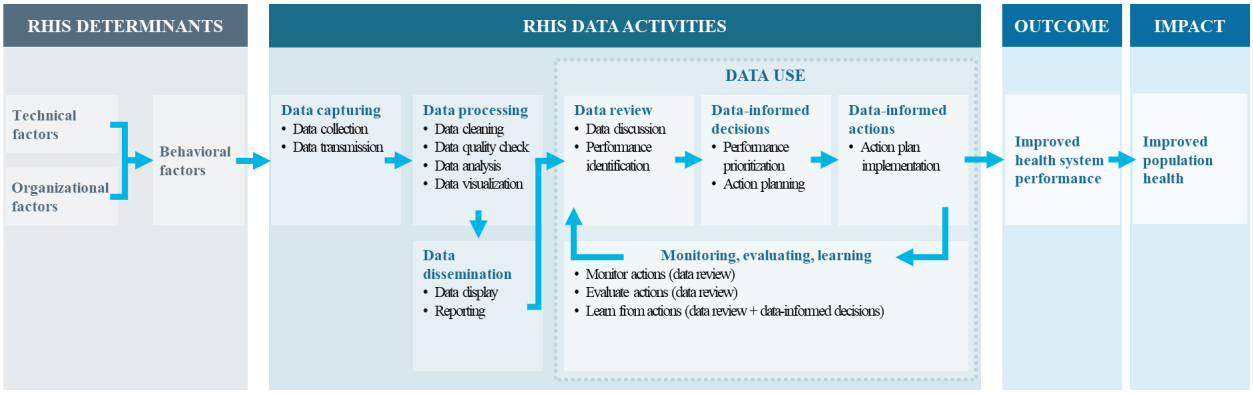
This longitudinal study aimed to assess the level of RHIS data use at facilities in Mozambique that participated in the Integrated District Evidence to Action (IDEAs) audit and feedback strategy to improve MNCH services and explored the organizational factors associated with translating RHIS data into action.

Conceptual framework and definitions

The refined Performance of Routine Information System Management (PRISM) framework, PRISM-Act (Figure 1) [35], served as the conceptual framework for this study, as it details the multi-step process of RHIS data use and explicitly conceptualizes data-informed actions as a step in the RHIS data use process. RHIS data use is defined as the process by which health staff review analyzed RHIS data to identify, address, and monitor performance gaps and priorities [35]. RHIS data-informed actions is a step in the RHIS data use process in which health staff implement actions planned based on review of health facility performance using RHIS data [35].

The PRISM-Act framework illustrates that data-informed actions are a critical step to achieving improvements in health system performance.

Figure 3: Performance of Routine Information System Management (PRISM) - Act framework



Intervention and setting

The IDEAs strategy aimed to improve RHIS and health system performance to improve services for women, newborns, and children, by supporting district and health facility managers to make data-informed decisions and implement evidence-based actions that are low-cost and align with organizational priorities. The IDEAs strategy was an iterative three step process of 1) a health system readiness assessment, 2) five-day district performance review and enhancement meetings, and 3) targeted facility support including mentorship by district and provincial managers and financial support. The performance review meetings were held semi-annually for each intervention district, uniting MNCH managers with district and provincial managers to analyze, visualize, and present RHIS data comparing secular trends in facility-level performance for MNCH services. Presentation of data was followed by group discussion to identify service gaps and support the development or updating of health facility improvement action plans. The highest performing and two lowest performing facilities, determined based on MNCH indicators, were then selected to receive targeted support, which included site visits by provincial and district managers and the IDEAs team, as well as limited financial support. The initial pilot of the

IDEAs strategy improved health system readiness and coverage of MNCH interventions and was found to be feasible to implement and user-friendly for frontline nurses as well as facility and district managers [100, 101].

IDEAs was implemented in all 151 primary health care facilities providing full maternity and child health services in 12 selected districts in Manica and Sofala provinces from 2016 to 2021. Intervention districts were purposefully selected based on large population size, a robust health facility network, and geographic accessibility to maximize resource investments. Information about the study setting and intervention have been previously published [90, 101-103].

Data collection

Action plan document review and targeted IDEAs support

During semi-annual district performance review and enhancement meetings, all participating health facilities developed action plans based on findings from the RHIS data and performance review. Action plans included information on the facility's priority performance gaps and planned actions to address these gaps. During the meetings, facilities would provide updates on the status of their planned actions, which were tracked in REDCap by the study team from 2016 to 2020 (corresponding to meetings 1 through 8) and categorized as "fully completed," "partially completed," and "incomplete." Actions that were implemented and achieved performance targets were categorized as "fully completed," while actions that were implemented but had not yet achieved performance targets were categorized as "partially completed." Actions not yet implemented were categorized as "incomplete."

Data on number of supportive site visits to highest and lowest performing facilities was tracked by the study team and stored in Excel.

Annual health facility surveys and data quality audits

As part of the IDEAs evaluation framework, annual health facility surveys and data quality audits (DQA) were conducted from 2018 to 2022 at a sample of 36 health facilities across all 12 intervention districts as well as a sample of 36 facilities across 12 matched control districts. Control districts were matched one to one with intervention districts based on district population, facility network, and geographic attributes. Three facilities from each district were selected: the highest volume facility, defined by the number of first antenatal care visits (ANC1) in 2017, and two additional facilities randomly selected among facilities with at least 200 institutional birth per year.

The health facility survey was modified from previously tested and used data collection tools [51, 100, 104-109] to collect data on facility characteristics such as staff size, frequency and quality of district supervision, organizational culture, and resource availability (Appendix A: Health facility survey). Surveys were conducted with primary health care facility managers and included review of documents to assess a facility's engagement in RHIS data activities such as evidence of meetings to review and discuss analyzed RHIS data.

For the DQA, a team of trained district health managers and study staff retrospectively extracted monthly data from paper-based health facility registries and summary reports for four key indicators to assess for data completeness: number of intrauterine devices placed, ANC1, institutional births, and third dose of diphtheria, tetanus, and pertussis vaccinations. These indicators were selected as they are key measures for essential reproductive, maternal, newborn, and child health services [3].

Study variables

The outcome variable was defined as the number of planned actions that were successfully or partially completed ("events") weighted by the number of actions planned ("trials") [S2: Data Dictionary].

Predictors to assess which organizational factors were associated with implementing planned actions were selected based on the PRISM-Act framework [35], the PRISM toolkit [51], and findings from prior studies exploring determinants of RHIS data use [10, 11, 19, 31, 35, 50, 53-55, 58, 63, 102, 103]. Predictors included in the model were:

1. The number of performance review meetings the facility had attended when the action was planned (between 1-8),
2. Whether the action was planned after the start of the COVID-19 pandemic,
3. The total number of actions planned by a facility during a performance review meeting,
4. Staff size, defined as the total number of nurses and health technicians,
5. Maternal health nurses to maternal service ratio, defined as the ratio of maternal health nurses to the average monthly number of first antenatal care visits,
6. Data quality measured as the percent completeness of health facility monthly summaries for four MNCH indicators,
7. Frequency of district supervision visits (none, every other month, monthly, more than monthly),
8. Quality of district supervision visit score calculated from eight binary measures,
9. Management training and style calculated from three binary measures (has no training and does not use standard management practices, has training or practices one standard, has

training and practices one standard or has no training and practices two standards, has training and practices two standards)

10. Frequency of health facility management committee meetings (none, infrequently/less than every quarter, quarterly, monthly or more),
11. Organizational culture score calculated from 16 Likert scale measures,
12. Facility resource barriers measured by facility staff reporting that lack of adequate infrastructure, or staff availability, or financial resources, is the top barrier to health facility functioning, and
13. The number of IDEAs support visits received.

Statistical analysis

Data were cleaned and analyzed using R Studio (v. 2022.02.0+443). Descriptive analysis was conducted to summarize the number and spread of actions planned and implemented.

A five-step process was used to assess the association between the outcome and selected predictors. First, an unadjusted mixed effects logistic regression model accounting for clustering at the health facility was fit for each predictor to assess its association with implementing planned actions. Second, a multivariable mixed-effects logistic regression model with all the predictors were fit. Odds ratios (ORs) or adjusted ORs (aORs) and 95% confidence intervals (CIs) were calculated to assess the strength of the association. Predictors with a p-value of <0.05 were assessed to be significantly associated with the outcome. Third, a likelihood ratio test was performed to assess the significance of the association of the categorical predictors in the model to the outcome. Fourth, a correlation matrix using Spearman rank correlation was built to assess for collinearity of the predictors. Correlation coefficients $\rho>0.7$ or < -0.7 were assessed to be strongly correlated [110], indicating a need to determine whether one of the variables should be

excluded from the model, guided by evidence from the literature and the conceptual framework. Lastly, Variable Inflation Factors (VIF) scores were assessed to detect multicollinearity in the multivariable model. A VIF score of 10 or greater was the level set to indicate that review of the predictor was needed to determine whether it should be excluded from the model.

Ethical considerations

This study was approved by the institutional review boards of the University of Washington (#STUDY00003926) and Mozambique's Ministry of Health (#IRB00002657), after endorsement from national-level Ministry of Health and the Provincial Health Directorates in Manica and Sofala. Surveys were conducted after obtaining written informed consent from participants.

Results

Health facility characteristics

Study facility characteristics are presented in Table 1. Smaller facilities with fewer than 10 staff had an average of 4 nurses and technicians (range: 1-9), compared to larger facilities with 10 or more staff that had an average of 43 nurses and technicians (range: 17-80). The ratio of maternal health nurses to the number of monthly ANC1 visits was 1:52 at smaller facilities compared to 1:23 at larger facilities. Staff noted that inadequate infrastructure (n=17 facilities, 53%) or limited staff availability (n=12 facilities, 38%) were the top barriers facilities faced in achieving optimal performance. Most facilities (92%) reported to have an active health facility management committee that met at least quarterly to review and discuss data to inform facility decision making. Average data completeness of monthly facility reports for four MNCH indicators was high at 86% (range: 0-100%).

Table 3: Characteristics of study facilities (N=36)

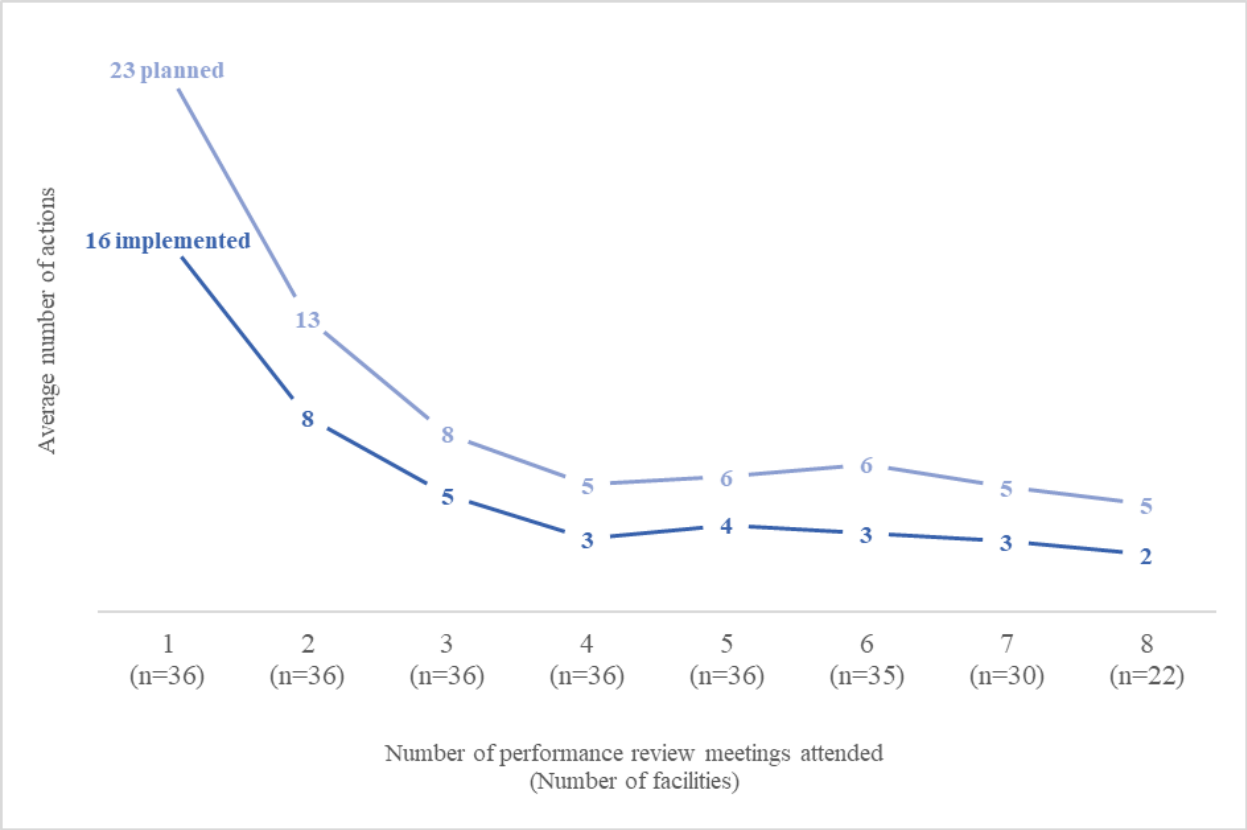
Characteristics	Mean (min-max)
Staff size, nurses and technicians	21 (1-80)
Smaller staff size (n=21)	4 (1-9)
Larger staff size (n=15)	43 (17-80)
Maternal health nurses to antenatal service level	1:40 (1:1-149)
Smaller staff size (n=21)	1:52 (1:13-149)
Larger staff size (n=15)	1:23 (1:1-62)
Percent data completeness	86 (0-100)
Organizational culture score	4.3 (3.3-5)
Actions planned per performance review meeting	9 (1-42)
IDEAs support visits received	5 (0-17)
Characteristics	**Number of facilities (%)**
District supervision visits in the last 6 months	
<3 times (i.e., less than every two months)	11 (31)
3- 6 times	19 (53)
>6 times (i.e., more than monthly)	6 (17)
Quality of district supervision visit	
Low	5 (14)
Medium	16 (44)
High	15 (42)
Management experience and style	
Low	7 (19)
Medium	21 (58)
High	8 (22)
Health facility management committee	
No committee/committee does not meet	0 (0)
Committee meets infrequently	3 (8)
Committee meets at least quarterly but less than monthly	14 (39)
Committee meets at least monthly	19 (53)
Top barrier to proper facility performance	
Inadequate infrastructure	17 (53)
Limited staff availability	12 (38)
Limited financial resource	3 (9)

RHIS data use: Action planning and implementation

The 36 sampled health facilities attended an average of 7 (range: 6-8) out of 8 possible performance review meetings between 2016 to 2020. During this time, facilities implemented a total of 1567 actions out of 2462 planned actions (64%). On average, facilities planned a total of 68 actions (range: 41-120) between 2016 and 2020, averaging 9 actions (range: 1-42) during each semi-annual performance review meeting. Facilities planned the highest number of actions during the first meeting, with numbers steadily decreasing over the first four meetings, and then plateauing at an average of five to six actions per meeting (Figure 2). Overall implementation of planned actions across all facilities was steady over the review meetings (mean: 60%, range: 53-

66%), though there was wide variation across individual facilities, with some facilities not having implemented any actions over the past six months while others had implemented all their planned actions.

Figure 4. Average number of actions planned and implemented across performance review meetings, 2016-2020



Factors associated with RHIS data-informed actions

The results of the unadjusted and adjusted analyses are presented in Table 2. In both the unadjusted and adjusted models, the number of actions planned was significantly associated with the likelihood of implementing a planned action, with the likelihood increasing by 2% for every additional action planned (aOR: 1.02, CI: 1.01, 1.03). Facilities where the manager had official training in health facility management, kept records of staff attendance, and conducted annual performance reviews were 1.8 times more likely to implement planned actions than facilities

where the manager had no training and did not practice these standard management activities (OR: 1.79, CI: 1.16, 2.75), though this positive significant association was only detected in the unadjusted model. Facilities where staff cited inadequate infrastructure as the top barrier to proper facility performance, compared to facilities that did not cite it as the top barrier, were significantly more likely to implement planned actions (OR: 1:38, CI: 1.04, 1.84), though this association was not significant in the adjusted model.

Table 4: Factors associated with RHIS data-informed actions in Central Mozambique, 2016-2020

Factors	**Model A** (unadjusted)[a] Odds Ratio (95% CI)	**Model B** (adjusted)[b] Adjusted Odds Ratio (95% CI)
Number of performance review meetings attended	**0.90**** (0.88, 0.94)	1.01 (0.94, 1.08)
Number of actions planned	**1.02**** (1.02, 1.03)	**1.02**** (1.01, 1.03)
Action planned after COVID-19	**0.61**** (0.43, 0.87)	0.84 (0.54, 1.31)
Staff size, nurses and technicians	1.00 (1.00, 1.01)	1.01 (1.00, 1.01)
Maternal health nurses: monthly ANC1 visit	1.00 (1.00, 1.00)	1.00 (1.00, 1.01)
Data quality, completeness	1.00 (0.99, 1.00)	1.00 (0.99, 1.01)
District supervision, frequency		
0 visits in 6 months	reference	reference
Every other month or less (≤3 visits in 6 months)	0.97 (0.63, 1.49)	0.93 (0.52, 1.68)
Monthly or less (≤6 visits, >3 visits in 6 months)	1.27 (0.83, 1.95)	1.06 (0.59, 1.92)
More than monthly (>6 visits in 6 months)	0.95 (0.59, 1.60)	0.68 (0.31, 1.48)
District supervision, quality	1.00 (1.00, 1.01)	1.00 (0.99, 1.01)
Management training and style		
None (no training and no standard practice)	reference	reference
Low (has training or practices 1 standard)	1.05 (0.70, 1.55)	0.83 (0.50, 1.38)
Medium (has training and/or practices 1-2 standards)	1.30 (0.90, 1.88)	0.79 (0.47, 1.30)
High (has training and practices all standards)	**1.79**** (1.16, 2.75)	0.81 (0.46, 1.45)
Committee meeting, frequency		
No committee/did not meet in 12 months	reference	reference
Meets less than quarterly	0.94 (0.64, 1.36)	0.99 (0.65, 1.49)
Meets quarterly	0.96 (0.66, 1.39)	1.19 (0.75, 1.86)
Meets monthly	1.08 (0.75, 1.58)	1.36 (0.87, 2.14)
Organizational culture score	1.13 (0.81, 1.57)	1.42 (0.95, 2.14)
Top barrier to proper facility performance		
Inadequate infrastructure	**1.38*** (1.04, 1.84)	0.90 (0.66, 1.25)
Limited staff availability	**0.57**** (0.44, 0.75)	**0.52**** (0.36, 0.75)
Limited financial resources	**0.42**** (0.23, 0.76)	**0.42**** (0.23, 0.78)
IDEAs site visit	1.00 (1.00, 1.00)	0.95 (0.84, 1.07)

Abbreviations: CI=confidence interval, ANC1=1st antenatal care, IDEAs=Integrated District Evidence to Action
*p<0.05, **p<0.01; bold text indicates statistical significance at p<0.0.5
a Model A: Bivariate generalized mixed effects logistic regression with action implemented as the outcome, clustered at the health facility
b Model B: Multivariable generalized mixed effects logistic regression with action implemented as the outcome, adjusted for all factors

Actions planned after COVID-19 were about 40% less likely to be implemented compared to actions planned before COVID-19 (OR: 0.61, CI: 0.43, 0.87), though this was not significant in

the adjusted model. Similarly, the likelihood of implementing planned actions was significantly and negatively associated with every additional performance review meeting attended in the unadjusted model (OR: 0.90, CI: 0.88, 0.94) but not in the adjusted model.

Facilities where staff cited limited staff availability (aOR: 0.52, CI: 0.36, 0.75) and limited financial resources (aOR: 0.42, CI: 0.23, 0.76) as the facility's top barrier to proper facility performance were significantly less likely to implement planned actions in both models.

Likelihood ratio test

The three categorical variables, district supervision frequency, management experience and style, and committee meeting frequency, all resulted in p-values >0.05 in the likelihood ratio test (p-value: 0.12, 0.80, and 0.34, respectively).

Correlation matrix and multicollinearity test

None of the predictor variables were strongly correlated, with correlation coefficients less than 0.7 or higher than -0.7. The most correlated variables were number of actions planned and number of performance review meetings attended (ρ = -0.62) and staff size and maternal health nurses: monthly ANC1 visits (-0.64). There was no indication of multicollinearity of the adjusted model, with VIF scores of less than five for all predictors.

Discussion

This study identified that about two-thirds of planned activities were implemented and a higher number of actions planned during performance review meetings was significantly associated with a higher likelihood of implementing planned actions. Further research is needed to explore the reasons for these findings. A higher number of planned actions may indicate higher enthusiasm for the IDEAs strategy or higher manager motivation for facility improvement. It could also be that facilities that planned a higher number of actions strategically

selected “light touch” actions that were easier to implement. A limitation of this study is that the number of actions planned and completed were counted equally, without weights to account for variations in the level of effort or length of time actions may take to implement, nor with consideration for the quality and effect of the action on the desired outcome. Future explorations may focus on understanding how to support facilities to increase implementation of planned actions and include an assessment of what types of actions are easier to implement and whether and to what degree these are associated with improvements in health service delivery. In Prakash’s innovative 2021 study tracking RHIS data-informed decision making in 25 districts in India, the study found a significant association between improvements in coverage outcomes and higher action plan completion rates [55]. The study also observed that once district managers started making decisions and acting on RHIS data-informed performance gaps, they were able to identify appropriate strategies to improve health outcomes. That is, the process of reviewing, planning, acting, and monitoring district performance seemed to contribute to increased effectiveness of district staff in improving service delivery.

Another finding from this study is that staff experiences of financial and human resource barriers were significantly and negatively associated with successful implementation of planned actions. Planned actions were about half as likely to be implemented when staff perceived limited staffing availability or financial resources to be the biggest barrier to optimal facility performance. Staff perception of inadequate infrastructure was positively and significantly associated with the likelihood of implementing planned actions in the unadjusted model, while it was negatively associated with the outcome in the adjusted model. This may be because selection of inadequate infrastructure as the top barrier indicates staff perception of fewer issues with availability of staff and financial resources. That is, this finding may be further evidence of

the association between staff perception of limited staff availability and financial resources with implementing planned actions. These findings align with a systems thinking approach, in that investments in all health system building blocks is critical for a well-functioning health system, and issues in one affect all other areas [111]. As other studies have concluded, taking a holistic, health systems approach by addressing widespread health system resource issues, particularly in staffing, is a critical element to optimizing RHIS data use [85, 102].

This finding also indicates that RHIS data-to-action strategies may be more successful if the strategy itself incorporates elements to moderate resource constraints. This aligns with findings from a qualitative evaluation of the IDEAs strategy, in which participants emphasized the importance of the financial and material support provided to the districts by the strategy in facilitating the implementation of planned actions [102]. A facility needs assessment prior to implementation could help identify the priority resource concerns of staff so that they may be addressed as part of the strategy. Though availability of resources is noted as a key organizational factor for RHIS performance in the PRISM framework [15], only one item in the PRISM toolkit [51], a commonly used set of data collection tools to assess RHIS performance, collects data on resource availability. This measure, "percentage of regions or districts that allocated financial resources for RHIS activities," only assesses resource investments at the district-level; no such measure exists at the facility-level. Part of the IDEAs strategy was to conduct annual facility service availability and readiness assessments (SARA) in a sample of facilities so that facilities could review the SARA results alongside analyzed RHIS data to assess the facility's achieved versus desired performance, including assessing the facility's available human and infrastructure resources. The SARA is a comprehensive health facility assessment

and monitoring tool that has been widely implemented across many settings [112, 113], and could be used to inform other comprehensive data-to-action strategies.

Many qualitative studies have found that the lack of available health workers, particularly nurses, is a substantial barrier to RHIS data use at the health facility level [10, 21, 26, 27, 85, 91, 92, 102]. In this study, staff expressing issues with the lack of available health workers was significantly and negatively associated with implementing planned actions, but the number of nurses and technicians and the ratio of maternal health nurses to monthly ANC1 visits were not significantly associated with the outcome. This may be because staffing data did not account for health worker absence nor for the increased workload pressures experienced by health workers in Mozambique due to task-shifting [114]. A 2020 study found the absence rate among doctors and nurses in Mozambique to be 22% [115], which can contribute to increased workloads and a heightened sense of human resource constraints [116]. Future studies may consider using the workload indicators for staffing need (WISN) measurement method to more precisely capture the workload pressures experienced by health workers. The WISN method is an approach to determine how many health workers are required for the workload of a given health facility and measures available working time, taking staff absences into account [117]. The WISN approach can also account for the actual scopes of practice of health workers, which is essential in the context of health workforce shortages and task shifting in which health workers, especially nurses, are expected to provide services that are outside their scope or without sufficient training and support [118, 119]. The WISN process itself can help identify critical staff training needs which could help to reduce workload pressures and perceptions of insufficient staff availability.

Most quantitative explorations of the determinants of RHIS data use come from Ethiopia [35], where studies have found that accountability structures and management practices such as

supportive supervision, performance evaluations, and regular feedback were associated with higher RHIS data use [50, 58, 60, 63, 65]. In this study, neither the frequency nor quality of the district supervision visits were associated with a higher likelihood to implement planned actions, though a trained facility manager using standard management practices was associated with a greater likelihood of implementing planned actions compared to an untrained manager not using standard practices. The difference in these findings may be due to the Ethiopia studies' focus on RHIS data review, dissemination, and decision making rather than on RHIS data-informed actions. That is, accountability structures may promote analyzed RHIS data to be reviewed and discussed to inform decision making but may not be sufficient to promote implementation of these decisions. This indicates a need to delineate RHIS data use activities such as data-informed decisions and actions when investigating and designing strategies to influence the determinants of RHIS data use. This delineation, as is presented in the PRISM-Act framework [35], may allow more precise diagnosis of the facilitators and barriers for each step of the process of translating data into action. This is critical, given that a persistent challenge in the RHIS data use field is that RHIS data-informed decisions often do not lead to actions that promote improved health facility performance [19, 28, 29].

Conclusion

This study fills a critical gap in the RHIS data use literature by describing the patterns of RHIS data-informed planning and action among health facilities participating in a data-to-action strategy in Mozambique and using longitudinal analysis to explore what organizational factors are associated with translating RHIS data into action. Findings indicate that strategies that support health facilities to develop action plans informed by RHIS data may promote increased implementation of actions to improve health facility performance. Findings also pointed to the

interconnectedness of the essential health system building blocks, with limitations in availability of staffing and financial resources as barriers to effective implementation of RHIS data-informed actions. This implies that investments in the health workforce are an essential part of RHIS optimization, which in turn will lead to improved health system performance and contribute to the achievement of universal health coverage and improved population health.

Appendices

Appendix A: Health facility survey

Note: This is an excerpt from the REDCap survey, including only items relevant to this study.

Instrument: Facility Service Availability and Readiness Assessment
1. Clinic ID
2. Province
3. District
4. Date
5. Please tell me how many employees, state agents and contractors with the following qualifications are currently assigned to this facility. Please count each worker only once, based on their highest technical or professional qualification and include both full and part-time workers. a. Nurse – higher education b. Nurse – general medium level c. Nurse – basic level d. Nurse – elementary level e. Nurse, maternal health – higher education f. Nurse, maternal and child health – medium level g. Nurse, maternal and child health – basic level h. Nurse, midwife – elementary level i. Technician, general medicine – medium level j. Technician, preventive medicine – medium level k. Agent, preventive medicine – basic level l. Agent, curative medicine – basic level
Instrument: Health Facility Management
1. Clinic ID
2. Province
3. District
4. Date
District supportive supervision visits
5. During the past 6 months, how many supervision or technical assistance visits have you received from representatives of DPS or SDSMAS?
6. On the last visit, did the supervisor (all Yes/No responses): a. Use a checklist? b. Meet with the facility staff? c. Observe external consultations? d. Review the registers? e. Review the medicine stockout records? f. Review financial records? g. Write feedback in the supervision book? h. Present and discuss the results with the facility staff?
Facility management (all Yes/No responses)
7. Have you ever received official training in health facility management?
8. In the last 12 months, did you (the person in charge of the health facility) have an individual meeting with each of the workers to review and evaluate their performance?
9. Does the health facility keep records of employee absences and attendance (ask to see evidence)?
Health facility management committee
10. Is there a Health Management Committee at this facility (Y/N)?

11. In the past 12 months, how many times has the Health Management Committee met?
Organizational culture (All 5-point agreement Likert scale)
12. There is good communication between the staff at this facility.
13. The most senior or experienced staff at this unit is available to discuss patient care issues.
14. Staff are encouraged to come up with new ideas.
15. Staff participate in decision-making on important facility related matters.
16. The staff like to work at this facility.
17. There are regular staff meetings to discuss how to achieve facility goals/objectives.
18. The staff at this facility have the ability to determine how to perform their daily work tasks.
19. The staff at this facility trust each other.
20. The staff at this facility receive training to improve their skills.
21. If two people had joined this facility five years ago and one was much better at their job than the other, they would be promoted more quickly.
22. Conflicts between staff members are resolved in an appropriate matter.
23. The use of data to control and improve service provision is considered in this facility.
24. The effort to achieve the facility's objectives are equally distributed among the individuals of this facility.
25. Staff performance is measured fairly and objectively.
26. Staff members who continually outperform others are rewarded or promoted.
27. Staff members who continually underperform are penalized.
Barriers
28. What do you think is the biggest limiting factor for the proper functioning of this health unit? a. Availability of medicines b. Staff availability c. Lack of trained personnel d. Lack of adequate infrastructure e. Lack of equipment f. Lack of autonomy g. Lack of financial resources h. There are no limiting factors i. Other

Appendix B: Data dictionary

Variable Name	Type	Definition	Calculation Method
district	character	Name of district	-
clinic	character	Name of clinic	-
year	numeric	Year data was collected or year of source document (2016-2020)	-
meeting	numeric	Number of performance review meetings attended (1-8)	-
covid	binary	After COVID-19	0 = Years 2016 to 2019; 1 = 2020
implemented	numeric	Number of planned actions fully or partially completed	-
planned	numeric	Number of planned actions	-
imp_prop	numeric	Proportion of planned actions fully or partially completed	implemented / planned
staff	numeric	Number of nursing and technician staff at facility	Sum of responses to Facility Service Availability and Readiness Assessment Q5
staff_anc1	numeric	Maternal health staff to maternal service ratio	Monthly mean first antenatal care visit / sum of maternal and child health nurses (basic and medium levels)
data_quality	numeric	Percent annual data completeness across four indicators (# of IUDs placed, ANC1, institutional births, DTP3)	# of indicators with data / # of months collected (12) * # of indicators (4) (e.g., facilities with data for all four indicators for all 12 months = 48 / 48 = 100%)
ss_quant	categorical	Frequency of district supportive supervisions over last 6 months	Responses to Health Facility Management Q5 0 = never came 1 = came every two months or less (more than never) 2 = came every month or less (more than every two months) 3 = came more than every month
ss_qual	numeric	Quality of district supervision visits	Mean of responses to Health Facility Management Q6a-h * 100
management	categorical	Management training and style of facility manager	Responses to Health Facility Management Q7-9 0 = no training, no practice (performance review, attendance record) 1 = training and no practice or no training and one practice 2 = training and one practice or no training and two practices 3 = training and both practices
committee	categorical	Frequency of health facility management committee meetings in the last 12 months	Responses to Health Facility Management Q10-11 0 = no committee / no meeting 1 = less than quarterly 2 = quarterly 3 = monthly or more frequently
org_culture	numeric	Organizational culture of the facility	Mean of responses to Health Management Q12-27
barrier_infr	binary	Top barrier to facility performance is inadequate infrastructure	1 = Yes, 0 = No

Variable Name	Type	Definition	Calculation Method
barrier_staff	binary	Top barrier to facility performance is staff availability	1 = Yes, 0 = No
barrier_finance	binary	Top barrier to facility performance is limited financial resources	1 = Yes, 0 = No
ideas	numeric	Number of IDEAs support visits received	-

Chapter 5. Conclusions

Summary of findings

The overall goal of this dissertation was to identify the determinants of translating routine health information system (RHIS) data into action to inform the development of more effective, targeted interventions that promote decisions and actions based on quality RHIS data. Literature synthesis, qualitative, and quantitative methods were used to pursue this goal. Several important findings were identified through this work.

First, as described in Chapter 2, RHIS data use is a multi-step process that includes data-informed decisions and actions, and it is the actions that lead to changes in health system performance. RHIS data use was defined to be a process by which health staff review analyzed RHIS data to identify performance strengths and gaps, collectively decide on performance priorities and action steps to build on strengths or address gaps, implement planned actions, and continuously monitor, evaluate, and learn from the implementation process. Explorations of the determinants of RHIS data-informed actions, described in Chapters 3 and 4, reinforced the importance of conceptualizing RHIS data use as a multi-step process, given that there are some differences in the determinants for each RHIS data use step.

Second, as described in Chapters 3, regular facility meetings to review RHIS data as a group to discuss and monitor health facility performance was an important determinant of translating RHIS data into action. This is a key finding in that while the organizational context affects whether meetings are held and who participates, it is the characteristic of the performance review process that influences whether RHIS data-informed decisions are made, and subsequent actions are taken.

Additionally, both qualitative and quantitative explorations identified that health facility staff experience of health workforce shortages is a major barrier to translating RHIS data into action. While it is well-established in the qualitative literature that the shortage of nurses is a barrier to RHIS data use, this is the only study statistically identifying the significance of this association; among the more than 400 RHIS data use studies screened for the integrative review, none explored this relationship quantitatively.

Lastly, Chapters 2 and 4 contribute to improving measurement approaches to RHIS data use. Chapter 2 summarizes the strengths and weaknesses of current approaches in measuring and reporting RHIS data use and offers specific exemplars of RHIS data use measurement and reporting. Given the limited number of studies reporting on RHIS data-informed decisions and actions and even fewer longitudinal analyses of RHIS data use, the methods described in Chapter 4 can inform methodologies of future RHIS data-to-action studies.

Implications for policy and practice

Findings from this dissertation have implications for policy and practice. First, continued investments in expanding and retaining the nursing workforce in Mozambique and other settings with health workforce constraints is critical in optimizing RHIS data use. Nursing shortages at health facilities mean high workloads, with little time for tasks beyond the delivery of health services [10, 21, 26, 27, 85, 91, 92]. Mozambique, with 0.47 nurses and midwives per 1,000 people [120] and 0.09 physicians per 1,000 people [121], is well under the universal health coverage universal health coverage (UHC) minimum workforce availability target of 4.1 skilled health workers per 1,000 population [122]. While RHIS data can inform improvements to facility processes to increase efficiency, addressing this widespread human resource challenge in LMICs is an essential component to promoting RHIS data use [85].

Practitioners can use the PRISM-Act framework to diagnose the facilitators and barriers facilities face in translating data into action at every step of the RHIS data use process, enabling the development of more targeted, effective interventions to promote RHIS data use. This is critical, given the persistent challenge of limited decisions made and actions taken using RHIS data at the facility-level [19, 28, 29].

Recommendations for future research

This dissertation fills a critical gap in the RHIS data use literature by developing a more refined framework for RHIS data use; proposing and implementing improved and novel approaches to measuring RHIS data use; and identifying determinants of translating RHIS data into action in Mozambique.

Findings from this dissertation identified major evidence gaps in the RHIS data use literature. Overall, there is a need for more quantitative studies to better understand the level and determinants of RHIS data use across different resource limited settings, especially the level and determinants of RHIS data-informed decisions and actions. There is a paucity of studies that report on actual decisions made and actions taken by health facilities based on RHIS data. Further research is also needed to clarify the relationship between RHIS data quality and each of the RHIS data use steps.

Findings from this dissertation also generated new questions. For example, what kinds of facility-level actions are more likely to be implemented? Is feasibility of implementation affected by the organizational context? Which actions are most effective in improving health facility performance? Future research may also take a more complex approach to measuring "successful implementation of planned actions," by accounting for variations in the level of effort or length of time required to implement an action. Such studies will expand the much-needed evidence-

base to inform the design of more targeted, effective RHIS data-to-action strategies that ultimately lead to improved health system performance and contribute to the achievement of UHC.

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