Effects of primary healthcare reform on routine health information systems (RHISs): a mixed-methods study in Lesotho

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ABSTRACT

Background and objective The Ministry of Health of Lesotho and Partners In Health piloted the Lesotho National Primary Health Care Reform (LPHCR) from July 2014 to June 2017 to improve quality and quantity of service delivery and enhance health system management. This initiative included improvement of routine health information systems (RHISs) to map disease burden and reinforce data utilisation for clinical quality improvement.

Methods and analysis The WHO Data Quality Assurance framework’s core indicators were used to compare the completeness of health data before versus after the LPHCR in 60 health centres and 6 hospitals across four districts. To examine change in data completeness, we conducted an interrupted time series analysis using multivariable logistic mixed-effects regression. Additionally, we conducted 25 key informant interviews with healthcare workers (HCWs) at the different levels of Lesotho’s health system, following a purposive sampling approach. Interviews were analysed using deductive coding based on the Performance of Routine Information System Management framework, which inspected organisational, technical and behavioural factors influencing RHIS processes and outputs associated with the LPHCR.

Results In multivariable analyses, trends in monthly data completion rate were higher after versus before the LPHCR for: documenting first antenatal care visit (adjusted OR: 1.24, 95% CI: 1.14 to 1.36) and institutional delivery (AOR: 1.19, 95% CI: 1.07 to 1.32). When discussing processes, HCWs highlighted the value of establishing clear roles and responsibilities in reporting, fruitful communication, and parallel systems that necessitate their reinforcement.

Conclusion The Ministry of Health had a strong data collection rate pre-LPHCR, which was sustained throughout the LPHCR despite increased service utilisation. The data collection rate was optimised through improved behavioural, technical and organisational factors introduced as part of the LPHCR.

INTRODUCTION

Routine health information systems (RHISs) are designed to collect, process and use health information collected at a regular interval of a year to inform clinical service delivery as well as administrative and management systems.1 RHISs aim to improve patient/population health outcomes and strengthen health systems,2 3 and they play a central role in data collection, collation, validation, analysis, dissemination and decision-making.4 Within primary healthcare (PHC), RHISs seldom receive adequate resources to operate successfully in sub-Saharan African (SSA) countries.5

Historically, RHISs in low/middle-income countries (LMICs) have been paper based. However, over the last 25 years, electronic systems have been introduced, often by non-governmental organisations supporting vertical, selective and disease-oriented programmes.6 In certain instances, targeted interventions have given rise to fragmented and parallel systems that necessitate their own unique data collection requirements, forms, and indicators.7 8 To integrate disease-based programmes into a comprehensive PHC package, it is necessary for RHISs to be strengthened and coordinated to improve...
administration of the health system and the delivery and assessment of care.\textsuperscript{12–14}

Lesotho was behind on key millennium development goals aimed at improvement of maternal and child health outcomes.\textsuperscript{15} To address gaps and to strengthen primary care, the Government of Lesotho, in partnership with Partners In Health, launched the first phase of the Lesotho National Primary Health Care Reform (LPHCR)—a pilot—in April 2014, in four districts: Berea, Leribe, Butha Buthe and Mohale’s Hoek.\textsuperscript{15} The three main objectives of the LPHCR were to improve service delivery, strengthen health system management and empower professional village health workers. As a central input to chart progress, the Ministry of Health (MoH) enhanced the RHISs to map disease burden and to define and monitor progress against the United Nations Sustainable Development Goals of 2030—including achieving universal health coverage.\textsuperscript{16}

Health information is one of the six core building blocks of health systems.\textsuperscript{17} As such, the LPHCR included inputs and activities relevant to RHIS data collection, processing and utilisation. These inputs and activities were: the introduction of new data officers in the four district health management teams’ (DHMTs) Strategic Information Division; compilation of PHC indicators to facilitate quarterly DHMT performance meetings; the use of RHIS data for regular health facility mentorship and supervision; and the use of data for quarterly district-based and national health performance meetings.

Our study aims to evaluate the effect of LPHCR on RHIS, following a methodological framework previously applied in other low-resource settings.\textsuperscript{18–19} This study hypothesised that completeness of a core set of preselected RHIS data would improve with the implementation of the LPHCR in Berea, Leribe, Thaba Tseka and Mohale’s Hoek districts. To further support this hypothesis, key informant interviews (KIs) were completed with healthcare workers (HCWs) to explore their experience of the impact of RHISs within the LPHCR.

\section*{METHODS}

\subsection*{Study setting and population}

Lesotho is an LMIC with a population of slightly over 2 million in 2017 and geographically surrounded by South Africa (figure 1).\textsuperscript{20–21} There are 10 districts, and this pilot study included Berea, Butha Buthe, Leribe and Mohale’s Hoek. These four districts account for 40% of the total population in Lesotho. Berea and Leribe are semiurban districts located close to the capital, representing over 65% of the four districts’ population.\textsuperscript{20}

The Kingdom of Lesotho was one of the original member countries that ratified the Alma Ata Declaration in 1978 and implemented PHC as the key to the attainment of the goal of health for all.\textsuperscript{22–23} Yet, the Basotho population has been profoundly affected by the HIV pandemic, which still has the second highest HIV prevalence globally (22.7%).\textsuperscript{24} The WHO lists Lesotho as 1 of the 30 countries with high HIV and tuberculosis (TB) incidence rates.\textsuperscript{25} Because international funding was largely tied to the treatment of these two conditions in Lesotho,\textsuperscript{26} PHC became fragmented. By 2015, Lesotho had backslid on health indicators for maternal and child health.\textsuperscript{21–27} These districts, chosen by the MoH, contained...
66 health facilities including six hospitals, covering an estimated catchment population of 880,000 individuals.20

Procedures

Study design

We employed a mixed-methods study with a convergent parallel design to assess completeness of a core set of preselected RHIS data and factors influencing data completeness.26 Quantitative and qualitative data were collected in parallel, analysed separately and then merged for interpretation. This study considered full sampling for quantitative and purposeful sampling for qualitative interviews.29

Quantitative

The WHO Data Quality Assurance (DQA) framework was used to select key PHC indicators for data completeness assessment.30 Per this framework, completeness is defined as monthly health facility register data completion for selected PHC indicators (online supplemental file 1). For this study, data completeness was only selected due to limited information on the other dimensions of data quality.31 The WHO DQA framework provides guidance on which indicators and how to measure them using data collected from RHISs. This study compared trends of DQA indicators data completion in three time periods: pre-LPHC, LPHC, and LPHC with Test and Treat (TT). TT was a national health policy that universally rolled out antiretroviral therapy (ART) for persons living with HIV, regardless of their CD4 count.32 This national policy also included RHIS inputs for HIV and TB programmes, which may have also affected other PHC programmes.

Qualitative

We used the Performance of Routine Information System Management (PRISM) framework33 to guide interpretation of KIIIs focused on RHIS determinants, processes and outputs. Interpretation was structured using the PRISM framework by looking at organisational, technical and behavioural determinants, and RHIS processes and outputs (data utilisation). Organisational determinants analysed were: information culture, structure, resources, and roles and responsibilities at the different levels of the health system. Technical determinants assessed use of data collection forms, and the processes, systems and methods by which they are used. The behavioural determinants reviewed included the knowledge, skills, attitudes, values and motivations of people involved in data collection and utilisation.34 Lastly, RHIS processes—including data collection, transmission, processing, analysis, display, quality assurance and feedback—were analysed (figure 2).

Data collection

Quantitative

Quantitative data were extracted from health facility (n=66) paper-based registers in the four LPHC pilot
districts. To collect data for the study, paper-based data collection forms (online supplemental file 2) were digitised in District Health Information Software-2 (DHIS2). The study identified eight key primary health indicators from maternal and child health, HIV, TB and outpatient programmes, excluding malaria. Data were de-identified in aggregate each month at the facility level, collected from July 2013 through June 2017. Pre-LPHCR period was from July 2013 to June 2014, LPHCR period was from July 2014 to June 2016 and LPHCR/TT period was from July 2016 to June 2017. Tablets for DHIS2 data collection were encrypted and password protected, and devices were kept in a locked file cabinet. Data were collected from September 2017 through February 2018. Site-based data quality audits were conducted at the end of each facility-based data collection visit.

Qualitative

The qualitative team conducted KIIs following a semistructured format (online supplemental file 3) with HCWs in the following categories: former minister of health, MoH programme directors, district health managers, district public health nurses, health facility managers, community health worker coordinators and community health workers. Interviews were conducted in English or Sesotho, depending on the interviewee’s preference. Transcripts were stored in English in Dedoose, which also served as the basis for analysis. Audio-recorded interviews were transcribed in English in Dedoose by qualitative officers who conducted interviews, consisting of two individuals who were a Basotho and non-Basotho. Participant confidentiality was maintained by assigning unique identifiers to each interview.

Data analysis

Quantitative

Analysis began by descriptively assessing the average monthly data completion rate comparing the three study periods (pre-LPHCR, LPHCR and LPHCR/TT), for each indicator, district and facility type. Findings from this descriptive assessment determined independent variables for our regression analysis. For data quality assessments, the outcome of interest was monthly health facility data completeness for the eight WHO DQA indicators. A binary variable was created in our dataset indicating if any of the eight monthly PHC indicators chosen for this study were available or missing (0=indicators are missing, 1=indicators were available). The study included health facilities (n=66) that reported any numerical value as available, and ‘0’ for any missing data for each indicator. Interrupted time series (ITS) analysis was performed, entailing logistic mixed-effects regression with health facility random intercepts to assess the trend change over the three periods. This study modelled overall change above 10% between pre-LPHCR and LPHCR/TT periods. This 10% threshold was designated arbitrarily. Additionally, excluded were indicators with consistently over 90% completion rate during the three periods. The lmerTest package in R was used to model mixed-effects regressions. All quantitative analyses were conducted in R V.4.1.2. Equation for our model is included in the supplemental documents (online supplemental file 4).

Qualitative

Following the PRISM framework, emerging themes were organised under inputs to RHIS performance (organisational, technical and behavioural factors), processes affecting RHIS performance and RHIS output via data utilisation, using codes extracted from the transcripts. Double-blind coding was conducted to each transcript where differences were addressed by a consensus in a regular meeting. Transcripts in Dedoose were analysed using a thematic analysis approach. In the coding process, EB and MM read completed transcripts and applied child codes for level of health system (community, health facility, district or central MoH), data reporting process, data for quality assurance and improvements, workload, training and partners collaboration. Excerpts were summarised from these child codes to the parent codes referring to the themes using PRISM framework. In other terms, we grouped leading labels according to thematic groups selected from the PRISM framework. Coded excerpts were exported to Microsoft Excel to clean, organise and report main findings. The final findings are synthesised and included in the Results section.

Patient and public involvement

The public were not involved in the design, conduct, reporting or dissemination plan of our research.

RESULTS

There were 12 facilities each in Butha Buthe and Mohale’s Hoek districts, 17 facilities in Berea and 25 facilities in Leribe participating in the evaluation. We completed 25 KIIs: 6 interviews each in Berea and Butha Buthe, 5 interviews each in Leribe and Mohale’s Hoek and 3 interviews at the central MoH office (table 1).

Quantitative results

Descriptive results

Based on a descriptive analysis, the average data completion rate progressively increased from 85.8% to 97.3%...
through the three study periods among hospitals. Health centres reported a slight reduction in the completion rate from 90.1% in pre-LPHCR to 88.8% during LPHCR. However, this rate progressively increased to 94.2% during LPHCR/TT period (online supplemental file 5).

When assessed by DQA indicator, data completion rates increased over 10% during LPHCR period for first antenatal care (ANC), fourth ANC, institutional delivery and postnatal care (PNC). Immunisation indicator had a 99% data completion rate during pre-LPHCR, which was sustained in the following two study periods. Similarly, ART initiation and TB treatment initiation had over 90% completion rate through the three study periods (figure 3). Monthly changes in combined (all eight indicators) average data completion rate by district started above 70%, with gradual improvement over time (online supplemental file 6).

Regression results

Following descriptive assessment of data completion rate by indicator and following our criteria of indicator inclusion, of the eight indicators, the ITS analysis included first ANC, fourth ANC, institutional delivery, PNC and outpatient indicators. In the multivariate analysis adjusting for health facility type and districts, trends in monthly data completion rate were higher after versus before the LPHCR for: documenting first ANC visit (adjusted OR (AOR): 1.24, 95% CI: 1.14 to 1.36) and institutional delivery (AOR: 1.19, 95% CI: 1.07 to 1.32). This association was opposite for outpatient indicator (AOR 0.88; 95% CI: 0.82 to 0.95). We did not find statistically significant association during these comparison periods for fourth ANC and outpatient indicators. Trends in monthly data completion rate were higher after versus before the

<table>
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<th>Table 1</th>
<th>Background primary healthcare-related information in the four pilot districts and national</th>
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<td>Hospital</td>
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<tr>
<td>Health centre</td>
<td>15</td>
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<tr>
<td>Number of key informant interviews (KIs)</td>
<td>6</td>
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*Bureau of Statistics (Lesotho).
†KIs from the central MoH office based in the capital city, Maseru.
MoH, Ministry of Health.

Figure 3

The WHO Data Quality Assurance framework was used to select key primary healthcare indicators for data completeness assessment. Here we used this framework to assess the average completion rate during the three study periods. We included two time segments referring to LPHCR and Test and Treat (TT) implementation. ANC, antenatal care; ART, antiretroviral therapy; LPHCR, Lesotho National Primary Health Care Reform; TB Tx, tuberculosis treatment.
LPHCR/TT for documenting PNC (AOR 1.08; 95% CI: 1.05 to 1.10) and lower for first ANC (AOR 0.91; 95% CI: 0.87 to 0.95) and institutional delivery (AOR 0.93; 95% CI: 0.88 to 0.99). Figure 4 depicts the above results visually, and tabular outputs are included (figure 4 and online supplemental file 7). Similar outcome magnitude and direction were observed when we included seasonality and random-effects slope in our models.

**Qualitative findings**

Below are qualitative findings based on KIIs with individuals representing the different levels of the Lesotho health system. Leading labels are grouped under the core components of the PRISM framework.

The newly implemented organisational structure established clear roles and responsibilities for data completeness and reporting (PRISM organisational factor).

HCWs mentioned that the newly implemented organisation structure (online supplemental file 8) introduced clear roles and responsibilities to different HCWs who were also tasked with using routine data for decision-making. They stated that each level of the health system was tasked with reviewing performance using RHIS, before the LPHCR data at the district were compiled and sent to the ministry programme staff for review without analysis by district-based health teams.

So that [DHMT reorganization] was the first step, to create accountability or clear margins. This reorganization guided who is supposed to do and, who has to report to who and when...then it was clear on the method of reporting and the accountability and so-forth. (DHMT)

HCWs received training on RHIS data utilisation as part of comprehensive health system performance monitoring and reporting (PRISM organisational factor).

Respondents indicated that training was conducted at the different levels of the health system to prepare HCWs for the newly introduced organisational structure in the districts. Included in this training was RHIS data quality assurance and utilisation for performance management.

They (District Medical officers) were trained on LPHCR activities, and that kind of training program has given them the confidence to do things. (central MoH)

Motivation to collect, verify and report routine data improved following the bidirectional data-sharing mechanisms created by the LPHCR (PRISM behavioural factor).

There were a consensus among respondents on the improved motivation to collect and report routine data associated with the bidirectional information-sharing mechanism introduced by the LPHCR. It was mentioned that the bidirectional data-sharing mechanism gave a platform for implementers to communicate their successes and challenges with decision-makers at the district and central MoH levels. Respondents stated that facilities interacted with districts quarterly using their routine data to discuss progress and shortcomings. As a result, respondents agreed that it improved their awareness and motivation in using RHIS data.

There was a report produced from the district to be submitted to the higher level every month. So that made a point that I deal with my data, I compile a
Routine data reporting tools were provided to community and facility teams, along with support on how to complete them (PRISM technical factor).

Respondents mentioned availability of reporting forms for community health workers to report indicators related to maternal and child health, HIV and TB programmes conducted in the community level. They also indicated that these reports were reviewed monthly by supervisors, health facility nurse in charge and public health nurse. As for health facilities, routine reports electronically with the support of data clerk and Health Management Information System officer supervising the submission.

….there are forms to fill in that information. And they [districts] are also giving reporting tools that, as they are doing their work….they know that they need to document this and that and report on it. (central MoH)

Health facility managers were provided with computers to submit monthly reports (PRISM technical factor).

Respondents mentioned that each health facility nurse in charge was provided computers to submit their monthly report. There was a consensus whereby via this computer, facilities were submitting reports without leaving their workplace unlike in the pre-LPHCR period.

We use a computer to send them we no longer have to wait for someone from the DHMT to come here (health facility)... (health facility)

Quarterly PHC meetings facilitated the use of data to monitor and evaluate progress, which indirectly improved routine data completeness (PRISM RHIS outputs).

Respondents indicated that the reform enhanced quarterly PHC meetings in districts and nationally, by emphasising the use of data to assess health facility and DHMT performance. They believed this quarterly meeting promulgated data quality and data utilisation. They mentioned that each district had their own internal quarterly PHC review meetings. Then, the central MoH team conducted all district PHC meetings quarterly on different dates from district internal PHC meetings.

It is a three day workshop [quarterly district health meeting] all the partners are there all the health centers that are in our district, the staff from DHMT each facility will be present according to the indicators that according to all the services that we offered at the clinic we are presenting on them. After every two presenters we discuss and find solutions. (health facility)

Consistent transportation infrastructure strengthened mentorship and supervision visits to health facilities by the DHMT (PRISM RHIS outputs).

There was a consensus among respondents that the LPHCR project provided consistent transportation for DHMT staff to visit and provide mentorship to health facilities in the pilot districts. Respondents mentioned that this consistent availability of transportation strengthened routine mentorship and supervision—using data generated by health facilities—to provide targeted supportive supervision. Respondents mentioned that prior to the LPHCR, even with availability of transportation, supervisions were conducted sporadically.

Because now [LPHCR], even before visiting, the team visiting a facility…discusses the facility [performance], looking at data, looking at everything. So, kind of prioritizing certain questions before going to the health center – using what data is available…. then determine what we need to follow up on more directly. (DHMT)

DISCUSSION

Our assessment employed a mixed-methods study design to evaluate completion of routine health data reported by health facilities as well as factors influencing data completion and data utilisation associated with LPHCR.

Descriptive analysis indicated that the MoH already had a strong data completion rate pre-LPHCR, which was sustained with LPHCR despite an increase in service utilisation. With the reform, the data quality improvement efforts were optimised through improved behavioural, technical and organisational factors introduced by the LPHCR. Based on our quantitative analysis, we observed noticeable improvement in data completion for maternal and child health indicators: first ANC, completion of four ANC visits, institutional delivery and PNC. Vertical programmes such as HIV, TB and immunisation had a high completion rate before LPHCR and sustained with LPHCR.

Qualitative results using the PRISM framework offered complementary information, with interviewees expressing satisfaction with improved data quality. Based on these interviews, respondents (HCWs) underscored improved organisational structure, staffing, training, data reporting and analysis processes at all levels. Additionally, they mentioned quarterly PHC review meetings as an important part of the LPHCR that facilitated improved data quality and data utilisation practices.

During the LPHCR, DHMTs were equipped to support health facilities due to increased data generation and a data utilisation culture. Likewise, central MoH programme leaders encouraged and supported district teams following their quarterly PHC meetings. The reform strengthened data reporting processes across different levels of the health system, where health facilities had the ability to know what was happening in their catchment communities; DHMTs were routinely reviewing facility performance to make sure facilities falling behind received all the support they needed; and central MoH teams extended their support to district teams after reviewing monthly and quarterly performance data reported by the DHMTs. Though most findings were
positive, KIIIs also mentioned that facility-level HCWs were demotivated when data clerks from Berea district health facilities were phased out a year after the LPHCR roll-out. DHMTs and facility-level staff faced major challenges coordinating donors who had different competing monthly report priorities despite the organised structure introduced by the LPHCR. Explanation for the decrease in the trends of monthly data completion rate for some indicators during versus before LPHCR period was not raised during KIIIs.

Results from this study are particularly important for healthcare stakeholders in SSA looking to improve RHISs through a comprehensive investment in PHC. Though the LPHCR targeted some of the health system building blocks, it was a holistic, systematic intervention that touched various levels of the health system building blocks. Having a clear organisational reporting process and data-sharing platform was important in creating a bidirectional mechanism in information sharing, which optimises health service delivery and patient outcomes. Organisational factors are often bypassed due to precedence given to technical and clinical characteristics in RHIS evaluations, though it is an important characteristic influencing RHIS performance. Findings from this study highlighted the importance of incorporating organisational, behavioural and technical determinants of RHIS process and outputs to better understand factors influencing RHIS change. A strength of the study was the use the use of a mixed-methods design to evaluate changes in RHISs as part of the LPHCR.

In a recent LPHCR study conducted by Ndayizigiyi et al, the authors found that the quarterly average number of women who attended their first ANC visit rose from 1877 (SD ±263) pre-LPHCR to 2729 (SD ±287) in the last year of the intervention (LPHCR/TT). Observed data completion improvement during the LPHCR/TT period and during the LPHCR highlights the synergy between different national-level initiatives aimed at improving population health outcomes. Mixed-effects regression analysis showed that the association was not confounded by health facility type and differences by district. Per our model diagnostic using ANOVA, we did not find a significant difference in our result when we adjusted for seasonality or random slope. Following a lagged effect assessment using autocorrelation function (ACF) and partial ACF, a lag 1 autoregressive correlation (AR-1) was detected in our time series; however, we did not find a statistically significant effect of AR-1 on our model. Due to word limits in this journal, we chose not to report alternative models used for sensitivity analysis.

A limitation of the study was not setting comparison districts or facilities during the intervention for better causal inference. However, to account for this key limitation, the study reverted to using an ITS framework to evaluate before and after LPHCR trends in data completion in the same sites. Second, monthly data extraction from facilities was cumbersome and required extensive human and financial resources. Fortunately, facility and district administrators were instrumental in co-identifying and addressing gaps with the study team. Third, facility registrars were prone to displacement, damage and inconsistent storing procedures. To ensure quality of data reports, the data collection team conducted a thorough audit and follow-up with relevant health facilities and district team personnel before releasing data for analysis. As for qualitative data, though we were able to get important responses from all the KIIIs, a disproportional number of programme feedback about RHISs were collected from district and facility staff compared with central and community programme staff. Though it would have been interesting to further examine the unique impact of TT on RHIS, this study chose not to do this analysis due to the task being out of our scope.

Further studies assessing the cost of conducting similar research will be beneficial for policymakers to scale up this intervention to other sites in Lesotho or elsewhere. The study design used in this study could be improved by adding more KIIIs from central MoH staff and community teams, given availability of resources and approval from ethics committees.

In conclusion, Lesotho’s RHISs appear to have improved in pilot districts once the LPHCR was introduced. These results were sustained despite the substantial increase in PHC service utilisation in the four districts. Findings underscore the role of strengthening comprehensive PHC RHISs as a core input in shaping the success of health system reform.
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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Ethics approval This study involves human participants and received ethical approval from the Lesotho National Health Research Ethics Committee (ID 117-2017). Harvard Human Research Protection Program granted ethical approval for this study (IRB17-19888) for both qualitative and quantitative study tools.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

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