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Evaluating the effective use of DHIS2 for improving planning and implementing HIV, TB, Malaria, and Immunisation programs in Uganda, Bangladesh and Mali

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Executive summary

This study investigates the adoption and effectiveness of DHIS2 in supporting HIV, TB, Malaria, and Immunization programs across Uganda, Bangladesh, and Mali. Our findings indicate that the availability and timely submission of reports vary considerably by country and program. Adoption of DHIS2, defined as the regular use and reporting via the system, has shown significant variation, with higher levels of data quality (completeness, outliers, and consistency) observed in districts where adoption is stronger. Immunisation programs typically maintain higher data quality compared to other health areas.

The study identifies several factors driving DHIS2 adoption, including a user-friendly interface and regular data reviews. However, limited training, complex workflows, and a lack of appreciation for data hinder optimal data quality. Despite these challenges, DHIS2 has become a critical tool for stakeholders in visualising health data, identifying hotspots, and addressing health disparities.

Key recommendations include increasing local ownership of the system, simplifying workflows, providing targeted and needs-based training, and encouraging cross-sectoral collaboration to sustain the use of DHIS2.

Introduction

The routine use and management of information at different levels is one of the essential components of the health system. Persistent challenges in health information systems and the lack of quality data hampers the measurement of progress and hinders timely decisions toward program improvement. Specifically in lower middle-income settings, fragmented health information systems and the limited use of electronic health records for clinical care and decision-making have posed several health systems challenges. DHIS2 is an open-source configurable platform that facilitates the collection, analysis, visualisation, sharing, and validation of both individual-level and aggregate data. DHIS2 has been used as a general health management information system and also to support specific health programs, including the Expanded Program on Immunisation (EPI), HIV, tuberculosis, and malaria (HTM). DHIS2 has helped identify gaps in immunisation coverage, monitor malaria rates, track TB treatment, reduce stock wastage, optimise cold chain management, and follow up on immunisation reports. In addition, implementing the DHIS2 Tracker has improved the timeliness of national vaccine schedules, supported the monitoring of campaigns, provided case management, and reduced drop-out rates. Despite over a decade of investments, the evidence on the effect of such systems on data quality, timeliness of reporting, and decision-making is limited. This study describes the enablers and barriers to using the DHIS2 system to support operational, program, and policy decision-making in Uganda, Bangladesh, and Mali. This study aims to assess the level of adoption of DHIS2 functionalities across various health programs, evaluate the quality of data captured by the system, and identify the key facilitators and barriers to its adoption.

Additionally, it seeks to examine the effects of DHIS2 on health outcomes, decision-making processes, and overall health systems. Finally, the study will provide recommendations for enhancing the scalability, sustainability, and equity of DHIS2 in its implementation. The specific objectives of this study are:

a. **Objective 1:** To understand the key enablers and barriers for adoption, data availability, quality, use and analysis of the DHIS2 in general, DHIS2 packages for HTM and immunisation, and DHIS2 Tracker as well as associated data.
    a. Objective 1.1: To review DHIS2 system outputs and assess the effect on data availability and data quality.
    b. Objective 1.2: To understand the key enablers and barriers for the adoption, data use and analysis of DHIS2 packages for HTM and immunisation and DHIS2 Tracker.

b. **Objective 2:** To review the effects of utilisation of DHIS2, DHIS2 packages, and DHIS2 Tracker to improve health outcomes (HTM and immunisation outcomes) and health system outcomes.
    a. Objective 2.1: To understand the extent to which the utilisation of DHIS2, DHIS2 packages, and tracker to improve health system outcomes.
    b. Objective 2.2: To understand the extent to which adoption and use of DHIS2, DHIS2 packages and DHIS2 Tracker are associated with changes in health outcomes.

Methodology

The study uses a mixed-methods approach to triangulate quantitative secondary data analysis (DHIS2 system data) with qualitative findings from interviews with stakeholders across national and subnational levels.

Quantitative Analysis: DHIS2 system data was extracted for HIV, TB, Malaria, and Immunization programs in Uganda, Bangladesh, and Mali. This data was used to determine the adoption of DHIS2 aggregate (Table 1). A nationwide survey was also conducted to determine the adoption of DHIS2 packages and trackers.

Table 1. Approach to determine adoption for DHIS2 aggregate, package, and tracker

	Approach/definition	Other considerations
Aggregate	Secondary analyses of DHIS2 data: • Availability* of DHIS2 reports (reporting rate) • Timely submission of these reports by facilities to districts (timely reporting rate)	—
Package**	Online survey to assess extent of district wise availability, use, and training was performed	Often integrated with DHIS2 entity and not available separately
Tracker**	Online survey to assess extent of district wise availability, use, and training was performed	Patient level data not available for analysis

**For every district, % if facilities that have monthly DHIS2 reports available; Details in Annex*

***Bangladesh did not receive permission to conduct the national survey, and used alternate modalities; conducted in 6 shortlisted districts only*

Based on this analysis, districts were stratified based on their adoption level, and six districts from each country (two high, two moderate, and two low adopters) were chosen for in-depth analysis.

Data Quality Assessment: Within each country, we shortlisted 6 districts for in-depth analysis. For each program area, 1-2 disease specific indicators were chosen. Certain data quality parameters, adapted from the WHO Data Quality Review Toolkit were used to ascertain the data quality of these indicator-specific data. The following flowchart (Fig 1) and table (Table 2) summarises the data quality assessment approach.

Fig 1. Flowchart depicting methodology for data quality assessment

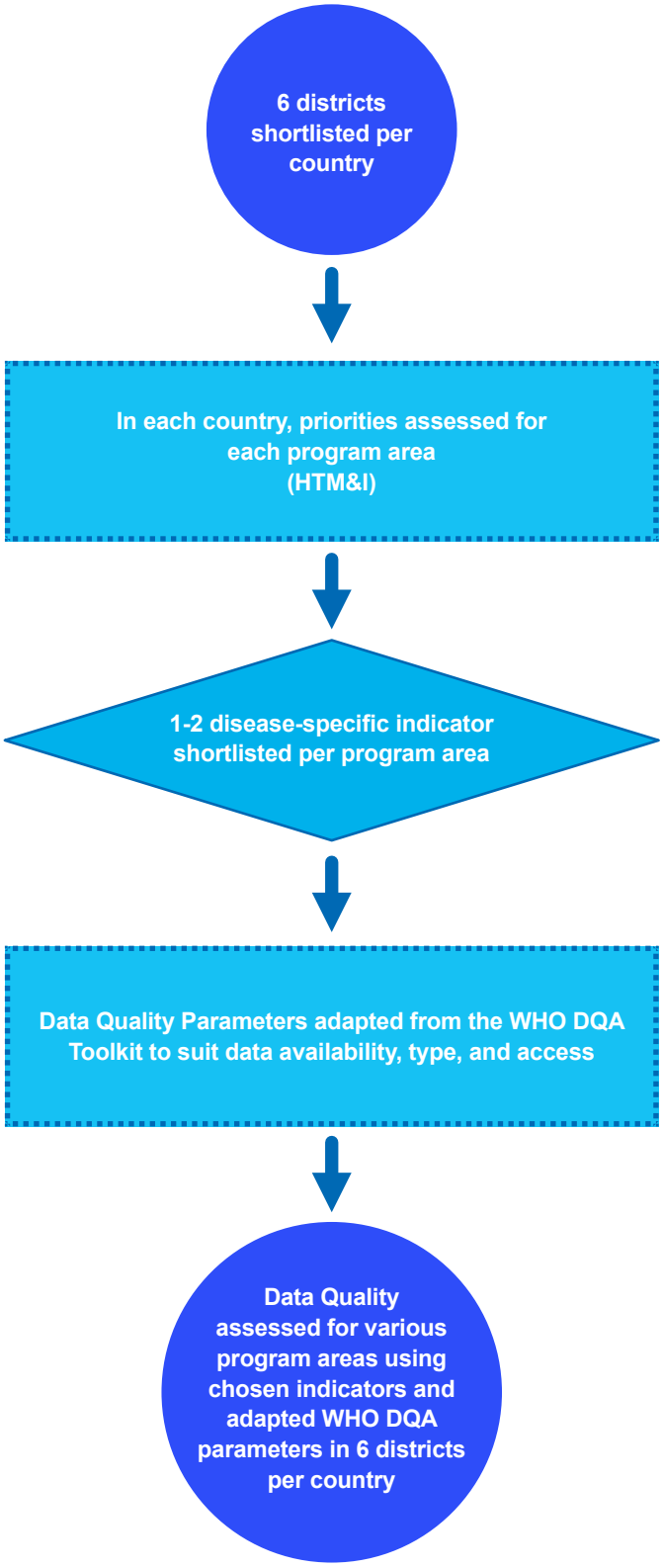


Table 2. Indicators used to determine data quality

Indicator	Definition*
Completeness of indicator data*	Proportion of non-zero entries for a specific variable in a month
Outliers (Extreme)*	Data entries that are outside of 3 standard deviations of the average for the period **OR** Outliers are identified as data points falling below Q1 - 1.5 * IQR or above Q3 + 1.5 * IQR
Validation Rules Analysis**	Data entries that violate validation checks configured within the system
Consistency over time*	Visual inspection of the graphs showing the monthly data reported within the system

**WHO DQA*

*** WHO Data Quality App configured with DHIS2 in Uganda*

**** Disease-specific indicators chosen in Annex*

Qualitative Inquiry: In-depth interviews were conducted with key stakeholders, including national and district health officials, healthcare providers, data entry operators, and program managers. These interviews explored facilitators and barriers to adoption, data use, data quality, and the effects of DHIS2 on health systems and outcomes.

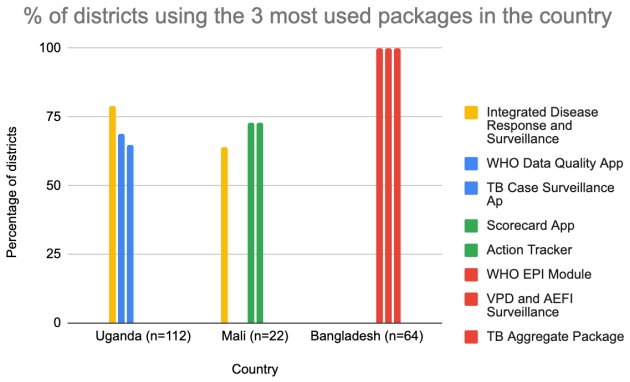
Results

Adoption and use of DHIS2 Aggregate, Tracker, and Packages

The adoption of DHIS2 aggregate varies considerably between and within countries. While the highest adopters had nearly 100% adoption of DHIS2 aggregate, low adopters reported a value of 6% in Mali, 13% in Bangladesh and 31% in Uganda. Aggregate adoption varies across program areas as well (Annex). This analysis guided the stratification of districts in high, medium and low adopters (Table 3) where the deep dive was performed.

Figure 2 displays the adoption of DHIS2 packages in the three countries, determined through a survey administered to district officials. Our findings suggest that training was provided for packages being most widely used. For example, 71 of 77 (92%) WHO Data Quality App users in Uganda received training for the package and 13 of 16 (81%) Scorecard App users in Mali received training for Scorecard App. Across Uganda and Mali, ~50% district officials surveyed reported receiving any annual training for any package (permission to conduct this analysis was not received in Bangladesh).

Fig 2. Bar chart of adoption of DHIS2 Packages in Uganda, Mali and Bangladesh.



Similar to packages, training was provided for trackers being most widely used too. For example, 75 out of 92 (82%) TB tracker users in Uganda received training for TB tracker. Across Uganda and Mali, ~35% district officials surveyed reported receiving any annual training for any tracker. COVID Tracker was used in Mali but scale is not known. Bangladesh reported the use of HIV tracker in 21 facilities only. It is important to note that for both Package and Tracker use, percentage of districts reporting use is equal to “any” use of the particular tracker. These estimates do not capture the intensity, consistency, or quality of use. See Figure 3 for more.

Fig. 3. Bar chart of adoption of DHIS2 Tracker in Uganda, Bangladesh and Mali.

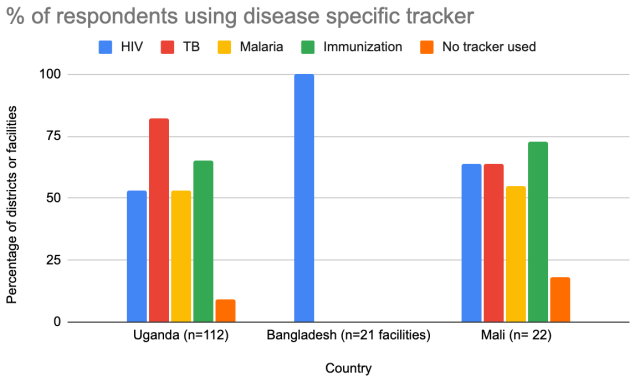


Table 3. Adoption levels for districts that were selected for further study across a range of adoption levels

	Uganda (district, adoption level)***		Bangladesh (district, adoption level)		Mali (district, adoption level)	
High	Yumbe	97%	Satkhira	95.9%	Bafoulabe	79.6%
	Maracha	90.9%	Rajshahi	93.4%	Kayes	79.6%
Moderate	Budaka	70%	Sunamganj	88.9%	Segou	66%
	Kakumiro	69.2%	Bandarban	78.2%	Niono	63.1%
Low	Buikwe	60.3%	Bhola	69.9%	Niena	51.5%
	Jinja	53.3%	Rangpur	65.3%	Koutiala	44%

We also conducted a total of 167 in-depth interviews to understand the drivers and inhibitors of DHIS2 adoption, use and the factors affecting data quality. Some of these are summarised in the tables below.

Table 4. Enablers for the adoption and use of DHIS2 system across countries

Enablers	Sub themes
Enabling infrastructure	Access to internet connectivity
	Availability of appropriate hardware (computers, phones)
	Stable power source (generators, solar energy)
	Availability of data collection tools (HMIS forms, registers, stationary)
User interface and system features	Ease of use (data analysis, interpretation)
	Reliability and easy accessibility
	Ability to detect errors and gaps in data
	New innovations and apps (Smart Paper Technology)
	Compatibility with different hardware
	System generated reminders
	Facilitates quick feedback on performance
Training, support and interpersonal reasons	Experience with other digital tools and tech-savviness
	Trainings and mentorship by MoH and implementing partners
	Commitment towards job and improved health outcomes of district
	Continuous medical education initiatives
Partnerships	Technical support through training, mentorships and troubleshooting
	Data entry support
Policy and legislation	Policy mandate to report
	Demand from supervisors and partners for outputs/deliverables
Incentives	Financial incentives based on higher performance
	Non-financial incentives by MoH as recognition
	Performance review meetings motivate completion of work
Financing	Use of Primary Health Care (PHC) budgets to finance data entry and review meetings

Table 5. Barriers to the adoption and use of DHIS2 system across countries

Barriers	Sub themes
Infrastructural inadequacies	Poor internet connectivity and network
	Unstable power and backup systems
	Stock out of tools, registers
	Obsolete hardware
Unsupportive system features	Prolonged system down-time
	Lack of systems user rights, access and login credentials
	Uncoordinated systems updates
	Non-intuitive user interface
	Data loss due to power and back-up
	Data entry mismatch
Human resource challenges	Insufficient staffing levels
	Work overload and poor remuneration
	Limited workforce capacity to use technology
	Fraudulent data collection, entry and reporting
	Lack of training for new tools
	High staff turnover in private facilities
	Limited on-the-job mentorship
Complex data entry protocols	Cumbersome system with many steps for reporting
	Time-consuming
	Dual burden of data collection (paper, digital)
	Non-streamlined data entry with many people at different stages
Over dependence on external agencies	Prioritisation of implementation partners' interests
	Dependence on partners for support instead of transition of capacity
Financial constraints	Lack of budget for equipment maintenance
	Funding cycles interrupt internet connectivity

Key takeaways

1. Across all countries, adoption of DHIS2 aggregate (defined as the average of health facilities within a district having availability of monthly reports and timely submission of these reports) varies considerably between districts and program areas. The lowest adoption was seen in Mali with districts having 6% timely submission of reports, and highs of near 100% were seen in all three countries.

2. Dashboards and aggregates allow managers to view reports, review data for completeness, consistency, clarity and aids in strategic decision-making, resource allocation, and to assess performance and disease burden. While they permit quick visualisation of the health status, their use by health facility managers is limited and they are used mainly by district biostatistician or at the national level.

3. Integrated Disease Surveillance Response package, WHO Data Quality App and Scorecard App were among the most widely used (use defined as any use by district officials) packages, while Tracker was most commonly used for TB and EPI followed by HIV.

4. Data Quality app is useful however it is up to the user to manually verify inconsistencies and take corrective action. Packages were poorly understood across all countries and use was commensurate with local priorities. Furthermore, package-specific training was seldom provided.

5. Trackers help monitor patients' health records and ensure personalised care and follow-up of specific patients closely. Utility of tracker is further appreciated in humanitarian scenarios when providing services to refugees however, use was limited due to knowledge gap. Training was provided for the most widely trackers.

6. Drivers of adoption include user-friendliness of the platform and complex reporting workflows inhibit use. While digital literacy was an enabler, the lack of module specific training was a barrier to adoption. Implementation partners supported adoption but hindered local ownership and often complicated the reporting process further by prioritising their programmatic interests. Furthermore, flexi-fund pools were an enabler, but being unable to maintain continuous funding for internet, equipment maintenance and data review meetings hindered adoption.

Data Quality Insights

The following graphs illustrate the completeness of disease specific indicator data (as defined in Table 2) in Uganda and Bangladesh. Bangladesh has higher completeness for all indicators, with immunisation data being 100% complete in several districts. In both countries, high adopter districts had higher completeness than moderate or low adopters. Between program areas, immunisation had higher completeness than others regardless of adoption status, especially for HIV.

Fig. 4. Illustrative graphs for completeness of indicator data in Uganda and Bangladesh

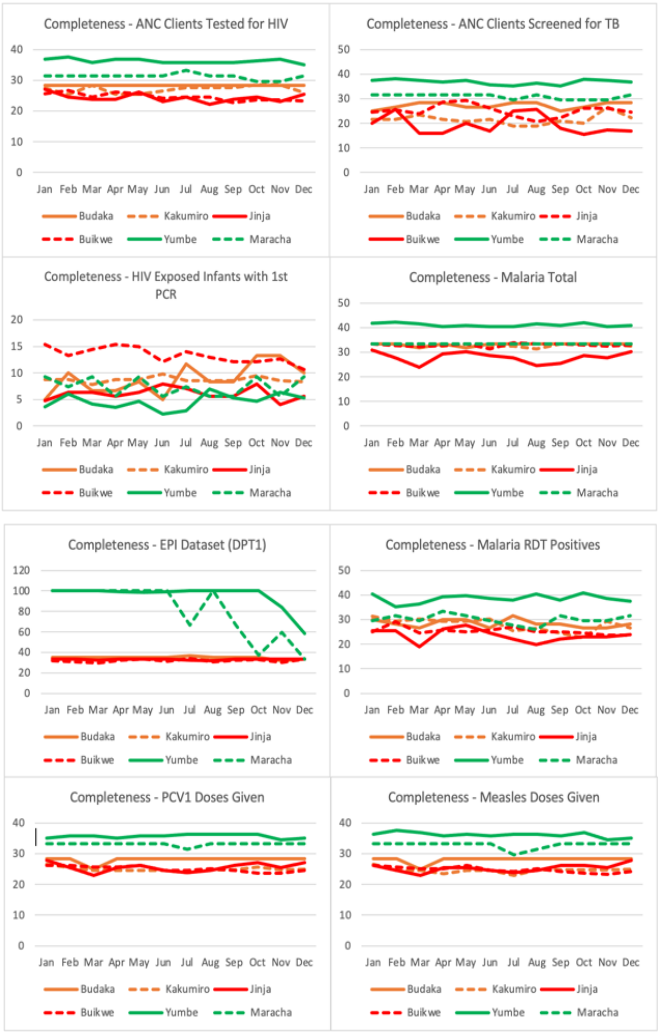
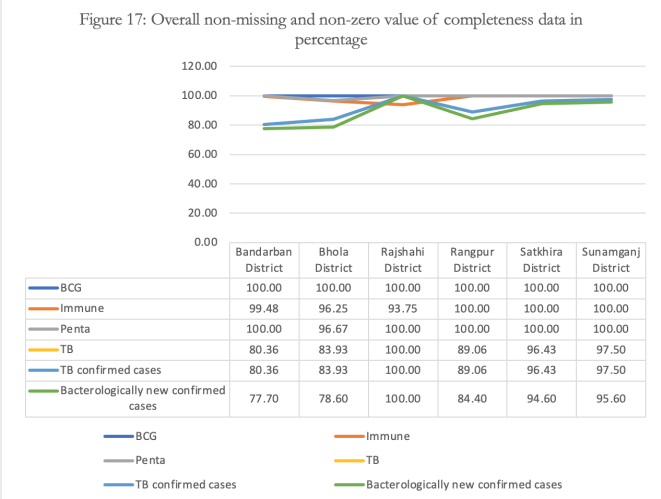


Fig. 5. Illustrative graphs for completeness of indicator data in Bangladesh



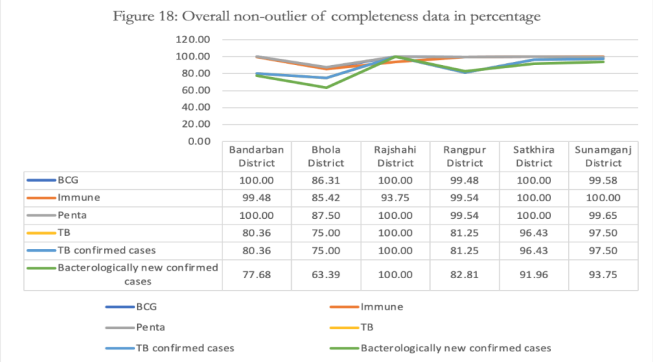
	Bandarban District	Bhola District	Rajshahi District	Rangpur District	Satkhira District	Sunamganj District
BCG	100.00	100.00	100.00	100.00	100.00	100.00
Immune	99.48	96.25	93.75	100.00	100.00	100.00
Penta	100.00	96.67	100.00	100.00	100.00	100.00
TB	80.36	83.93	100.00	89.06	96.43	97.50
TB confirmed cases	80.36	83.93	100.00	89.06	96.43	97.50
Bacterologically new confirmed cases	77.70	78.60	100.00	84.40	94.60	95.60

Similar to completeness, immunisation data was of higher quality in Bangladesh and had lesser outlier values than tuberculosis data. Out of 144 values, 12 (8%) outliers were detected. Out of these 12 suspected outliers, only 2 were of high probability and were reported in low adopter Ugandan districts. While higher adopters saw fewer outliers, they also had a higher number of data quality violations. Higher number of outliers were hypothesised to be due to an increased volume of clients who received services beyond targets or at outreach sessions. Whereas, high volume health facilities were hypothesised to be more likely to have errors (data quality violations) due to limited staff, overload and the need to beat deadlines.

The following graphs and figures help illustrate these findings.

In Uganda high adopters had higher consistency over time than low adopters. Similar to other data quality parameters, immunisation data were relatively more consistent than malaria data. Seasonal patterns were observed for malaria data in Uganda in high adopters indicating regular use of the system. Furthermore, variation in consistency was attributed to poor mobilisation, lesser uptake of services & lesser outreach sessions. The following line charts illustrate the consistency over time in Uganda.

Fig 6. Graph depicting outlier analysis in Bangladesh



	Bandarban District	Bhola District	Rajshahi District	Rangpur District	Satkhira District	Sunamganj District
BCG	100.00	86.31	100.00	99.48	100.00	99.58
Immune	99.48	85.42	93.75	99.54	100.00	100.00
Penta	100.00	87.50	100.00	99.54	100.00	99.65
TB	80.36	75.00	100.00	81.25	96.43	97.50
TB confirmed cases	80.36	75.00	100.00	81.25	96.43	97.50
Bacterologically new confirmed cases	77.68	63.39	100.00	82.81	91.96	93.75

Fig 8. Bar chart of data quality violations in Uganda by district

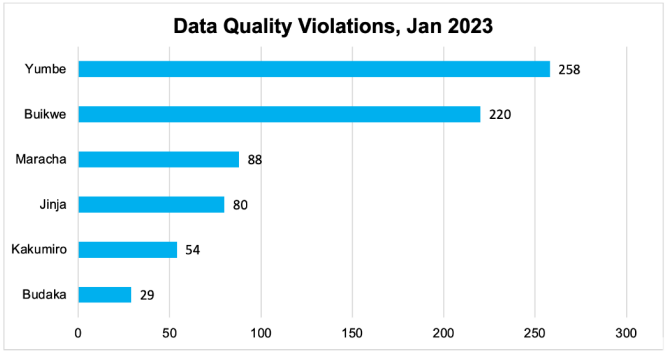


Fig 7. Illustrative heat map depicting outliers analysis in Uganda

	DPT1 Doses Given						PCV1 Doses Given					
	Maracha	Jinja	Kakumiro	Budaka*	Buikwe	Yumbe	Maracha	Jinja	Kakumiro	Budaka	Buikwe	Yumbe
Jan-23	666	788	1455	999	1856	3136	669	783	1403	1082	1820	3076
Feb-23	622	676	1424	930	1582	3006	617	665	1421	931	1570	3006
Mar-23	619	592	1494	841	1704	3293	613	603	1503	904	1698	3286
Apr-23	574	576	1381	936	1643	3312	570	581	1384	863	1654	3295
May-23	646	725	1390	1143	1960	3075	673	726	1400	1115	1946	3083
Jun-23	665	658	1473	1021	1665	3277	664	653	1471	1003	1642	3232
Jul-23	598	775	1555	999	1551	3225	600	775	1528	1051	1562	3173
Aug-23	679	298	1588	1150	1690	3470	674	320	1591	1143	1699	3477
Sep-23	601	521	1524	1048	1552	3270	599	543	1532	1082	1543	3269
Oct-23	852	902	1751	1425	1731	4242	842	913	1634	1518	1733	4242
Nov-23	730	719	1689	1179	1673	3623	724	731	1716	1323	1668	3691
Dec-23	742	617	1440	1182	1429	3656	743	622	1418	1156	1463	3626

Fig. 9. Consistency over time in immunisation data in Uganda

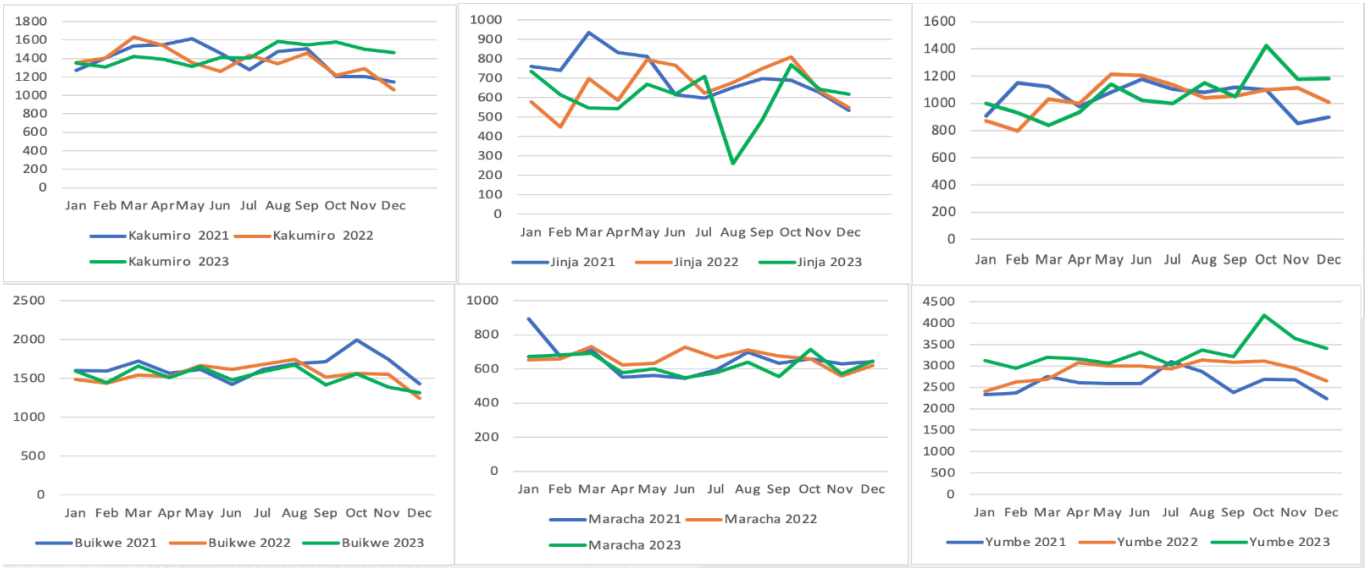
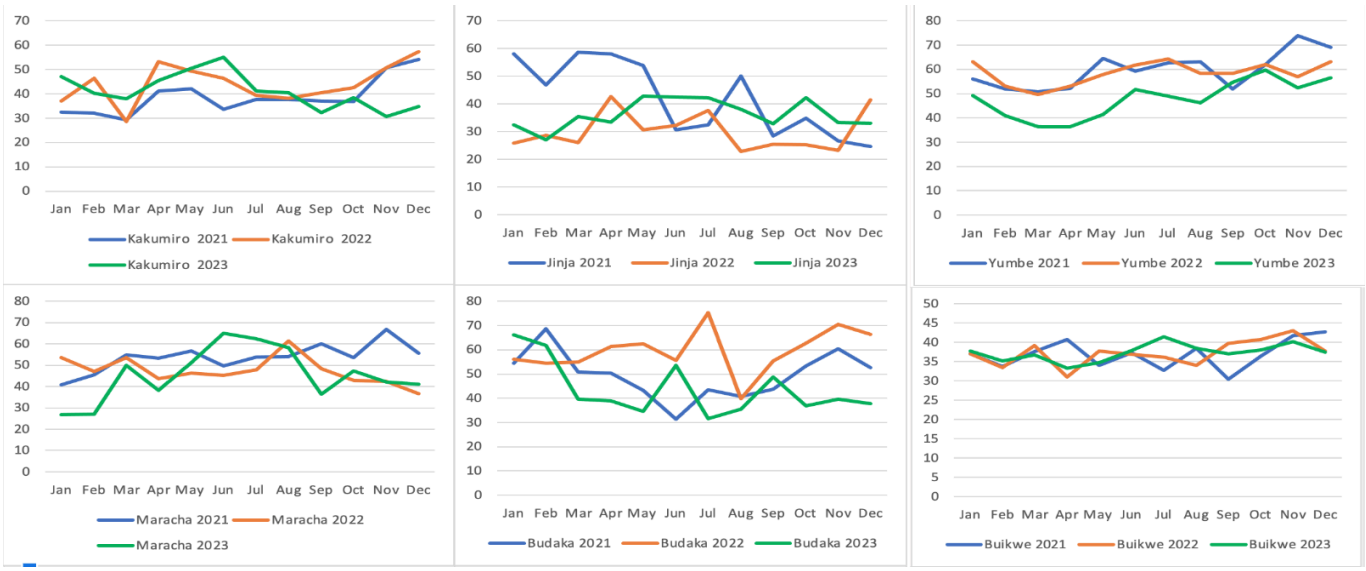


Fig. 10. Consistency over time in malaria data in Uganda



Key takeaways:

1. Irrespective of adoption level, immunisation data were of higher quality (parameters used are completeness, outliers, validation rules and consistency over time) than all program areas, specifically HIV data. Data quality within districts corresponded with their DHIS2 adoption level.

2. Between countries, Bangladesh had higher completeness (defined as missingness or zero values in data fields) than Uganda, followed by Mali.

3. Drivers for higher data quality were regular data review meetings, continuous data monitoring, supportive supervision and in-built data checks. However, lack of funding to hold review meetings, lack of training in using data-checks, and lack of appreciation of the value of data were barriers. While limiting the time-frame of reporting any data into DHIS2 was perceived to increase accuracy and limit fraud, it was also linked to increase workload and worsened data quality.

Effects of DHIS2 on health and health system outcomes

Key takeaways:

1. Our qualitative findings provide evidence that DHIS2 is deft at improving decision making, health outcomes and health system outcomes. The easy accessibility of data using the mobile and desktop interfaces provides quick visualisations and availability of data on 'fingertips'.

2. These data help improve program planning and logistics management and address health disparities by identifying catchment areas where service coverage needs to be strengthened. DHIS2 use has also led to increased retention in care for HIV and TB patients by facilitating patient level tracking and helped assess disease burden by providing a reasonable estimate of the population denominator.

3. DHIS2 data can be disaggregated by various socio-demographic indicators (sex, location etc.). This is helpful in using DHIS2 to detect hotspots where outreach services must be strengthened to alleviate health disparities. However, given the limited use of DHIS2 at the health facility level for decision-making, this effect may take time to realise as data flows up the health system and decisions are made at the district.

4. Technical capacity is strong among biostatisticians but weak at lower cadres. Training programs are inequitable, primarily focused on biostatisticians and cover limited topics.

5. Low motivation of private health providers, lead to delayed and incomplete data submission, affecting data quality. Limited integration of private health data into DHIS2 hampers a comprehensive view of trends.

Recommendations

1. Expand Training and Capacity Building

a. Needs-based training for all cadres: It's critical to increase the capacity of both higher and lower-level cadres through targeted, needs-based training. Training must be tailored to the specific roles of each cadre, ensuring that both managerial staff and frontline health workers are equipped to use DHIS2 effectively.

b. Online training and continuous communication: In addition to traditional in-person sessions, consider offering online training modules to facilitate flexibility and accessibility. Regular communication updates—especially concerning software updates or best practices—should be sent out in a timely manner to keep all staff informed.

c. Broaden training scope: Training programs should go beyond DHIS2 functionality and include basic IT skills, data analysis techniques, and problem-solving. This expanded scope will ensure that users are not only proficient with DHIS2 but also capable of troubleshooting common issues and making data-driven decisions.

2. Identify Pathways to Local Ownership and Smooth Transitions from External Support

a. Reduce donor dependence: Efforts should be made to lower the dependence on donor funding by enabling local capacity. This will encourage more sustainable use of DHIS2 and empower local health systems to function independently of external partner agendas.

b. Shift focus to sustainability: Transitioning away from temporary partner support will help prioritize long-term sustainability. This includes training local teams to manage, maintain, and troubleshoot DHIS2, fostering local ownership over health data management.

c. Decentralised decision-making: By decentralising access and decision-making to the facility level, local response teams will be empowered to act on DHIS2 data in real-time. This localized control encourages timely interventions and reduces bottlenecks caused by hierarchical decision processes.

3. Cross-Sectoral Collaboration Within Program Areas

a. Collaborative opportunities and integrated financing: Encouraging cross-sectoral collaboration can unlock new opportunities for shared funding and integrated approaches. By engaging multiple sectors, DHIS2 implementation and sustainability can be reinforced through diverse financial sources.

b. Sustained implementation through funding cycles: Cross-sectoral collaboration can strengthen implementation processes by ensuring that programs remain financially supported across different funding cycles, thereby minimising disruptions in DHIS2 usage.

c. Streamlining data collection: Cross-learning between program areas allows for a more streamlined approach to data collection and reduces the need for repeated training. This collaboration promotes the sharing of best practices and ensures a smoother implementation process.

4. Demystify 'Packages' and Focus on Adoption

a. Simplification of DHIS2 packages: There should be a concerted effort to simplify and popularise DHIS2 packages, making them more accessible and user-friendly. Sensitization of stakeholders, particularly at the district level and below, is key to improving adoption rates.

b. Stakeholder engagement beyond the national level: Engagement must extend beyond the national level to reach district-level health workers and managers. Sensitising various cadres will improve the adoption of DHIS2, ensuring that the system is used effectively at all levels of the health systems.

5. Need for Closer Assessment of Trackers

a. High cost and donor dependence: Trackers are essential frontline tools, but their implementation and maintenance require significant financial resources, often leading to greater reliance on donor funding. A thorough assessment of their cost-effectiveness is necessary.

b. Further research: Closer scrutiny of how trackers are being used is needed to ensure they are effectively adopted and utilised.

6. Data Quality Checks at the Facility Level

a. Simplified data verification: Implementing a procedure to simplify the verification of data quality errors can greatly enhance the accuracy of health data. Regular feedback loops at the facility level can help correct errors before they propagate through the system.

b. Capacity building in data interpretation: Facility-level staff should be trained in the interpretation of health data. This will not only improve data entry accuracy but also enhance the utility of DHIS2 data for decision-making at the local level.

7. Simplify Data Reporting Workflow

a. Address limited data entry support: In facilities where stakeholders have limited data entry support, simplifying the data reporting workflow is essential. Streamlined processes can reduce the burden on overworked staff, ensuring that data entry remains timely and accurate despite resource constraints.

Annexures

Annex 1. Indicators used to calculate 'Adoption'; note differences in program areas

	Uganda			Bangladesh				Mali		
	Proportion of health facilities reporting monthly	Proportion of health facilities reporting weekly	EPI Reporting timeliness	EPI monthly reporting rate	EPI Reporting timeliness	TB monthly reporting rate	TB Reporting timeliness	Reporting completeness rate	Reporting timeliness rate	Module Usage rate
Lower bound	30.8%	43.2%	56.7%	86.9%	54.6%	27.3%	12.6%	78.8%	6.1%	6%
Upper bound	99.8%	99.1%	99.5%	100%	100%	100%	98%	100%	97.8%	65%

Annex 2. Disease specific indicator used to determine data quality in Uganda

Program Area	Indicator	WHO DQA Recommended Indicator
Immunisation	EPI - DPT1 doses given	No
	EPI – PCV1 doses given	No
	Measles doses given	No
Malaria	Malaria total cases	No
	Malaria test positivity rate (Rapid Diagnostic Tests) (%)	No
HIV	%ANC clients tested for HIV (Total)	No
	%HIV exposed infants with 1st PCR test	No
TB	%ANC clients screened for TB	No

Annex 3. Disease specific indicator used to determine data quality in Bangladesh

Program Area	Indicator	WHO DQA Recommended Indicator
Immunisation	BCG vaccination	No
	Fully Immunized child (for age or over 5?)	No
	Penta vaccination	No
TB	Tested for TB	No
	TB confirmed cases/TB notification rate?	Yes
	Bacteriologically new confirmed cases	No