RESEARCH

Towards improving district health information system data consistency, report completeness and timeliness in Neno district, Malawi

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Abstract

Background Quality data is crucial in making informed decisions regarding health services; However, the literature suggests that in many LMICs including Malawi, it remains of poor quality. Data quality is measured in terms of completeness, timeliness and consistency among other parameters. We describe the Ministry of Health's District Health Information System (DHIS2) report completeness and timeliness at three levels: National, South West Zone (SWZ) and Neno district. Further, describe data consistency following data quality assessments (DQA) in Neno district, Malawi.

Methods We conducted a descriptive retrospective study by extracting DHIS2 report completeness and timeliness at three levels and used DQA data in Neno district between January 2016 and December 2022. We defined report completeness as the number of reports in DHIS2 against those expected, timeliness as the number of reports entered into DHIS2 before the deadline and consistency as the level of agreement between three sources: register, report and DHIS2 system. We presented the data graphically and calculated yearly median reporting rates for weekly, monthly and quarterly reports against the national target of 85%. We utilized a verification factor (VF) of 0–200% to evaluate consistency between three sources in the Neno district. VF exceeding 100% indicated over-reporting, 100% as a perfect match, and less than 100% as under-reporting, with an acceptable 90–110% range.

Results During the study period, we found increased trends in weekly, monthly and quarterly report completeness at all three levels but were below 85%. Neno district surpassed the target from 2020 onward for weekly reports and from 2019 onward for monthly reports. Similar increased trends were observed for report timeliness with below threshold of 85% except for Neno district monthly report from 2021 onward. We found inconsistencies in data entry from the report to DHIS2 (VF: >90% - <110%) in Neno district. Similarly, under and over-reporting occurred between the register and the report (VF: <90% and > 110%) were observed. These findings should be considered when using DHIS2 for decision-making.

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Conclusion In general, we found increased completeness and timeliness rates at all three levels, however, less than the set target of 85%. We suggest continued support, including routine DQAs and report monitoring, towards improving DHIS2 data quality.

Keywords Completeness, Timeliness, Consistency, Data quality assessment, Neno, DHIS2

Introduction

The World Health Organization (WHO) has identified six essential components for improving health systems: service delivery, health workforce, health management information systems (HMIS), access to essential medicines, financing, and leadership or governance [1, 2]. HMIS is responsible for generating and utilizing health data for program planning, monitoring and reporting [3]. For informed decision-making, the HMIS-generated data must meet specific metrics including completeness, timeliness, and consistency among others [4]. Data completeness is defined as the extent to which all required and expected data are present and timeliness is the extent to which data is made available before a predefined deadline [4]. A systematic review of 38 studies found that the completeness and timeliness of HMIS-generated data remains poor in low- and middle-income countries (LMICs [5]. These findings present substantial challenges in using HMIS data for effective planning at all levels.

Efforts to improve health systems and outcomes in Sub-Saharan Africa (SSA) through HMIS have been recognized [6–8]. However, challenges persist in the region, as studies have identified several factors contributing to the underperformance of HMIS. System-related factors such as infrastructure and human-related factors such as scarcity of skilled staff, are still affecting efforts toward improving HMIS data [7–12]. In recent years, there has been a substantial improvement in HMIS data completeness, timeliness and consistency in many countries including Malawi [13–15].

Malawi is a low-income country in southern Africa, with an estimated population of 18.4 million people in 2022 [16]. The healthcare system in the country is grouped into five health zones: North Zone with seven health districts, Central East Zone with five districts, Central West Zone with four districts, and South East and South West Health Zone (SWZ) with six and seven districts, respectively [17, 18]. Since 2002, Malawi's Ministry of Health (MOH) has been actively collecting and reporting aggregated data at the health facility level on services, disease epidemiology and administration through a unified HMIS under the Central Monitoring and Evaluation Division (CMED) [19]. Malawi strives to have high-quality data that supports informed decision-making as outlined in its Health Sector Strategic Plan II and III as well as Monitoring, Evaluation and Health Information Systems Strategy [20–22]. The country uses District Health Information System Version 2 (DHIS2),

a free, open-source software specialized in HMIS, also used by over 75 countries worldwide [23]. As of January 2023, 1266 health facilities both government-owned or private for profit and private for non-profit were reporting in HMIS based on DHIS2 data [unpublished]. Malawi adopted WHO 85% as a target for DHIS2 reporting completeness and timeliness for weekly, monthly and quarterly reports [2, 24, 25].

In theory, and where resources are available, including infrastructure like electricity, internet and computers, all health facilities in Malawi have the potential to report data using the online DHIS2 system [26]. However, in practice, the reporting process often involves distributing physical reporting forms to health facilities. These forms are used to compile weekly, monthly, or quarterly reports from the registers of different programs. Subsequently, the HMIS team, primarily data clerks and program coordinators, collects the forms and forwards them to the HMIS office at the district level, where data entry into the DHIS2 system is done [17]. Some of the challenges with this approach include poor timeliness and missingness, among others [17, 27]. Studies done in Malawi have also lamented the poor quality of the data available in DHIS2 and suggested efforts including quality improvement projects like Data Quality Assessment (DQA), increasing human resources and decentralisation of data entry to the lowest level [12, 18, 25, 27, 28].

Abwenzi Pa Za Umoyo (APZU), Partners In Health, has been working closely with the Malawian Government and Ministry of Health since 2007 [29, 30]. Their focus has been on improving community-based disease prevention by utilizing Community Health Workers and supporting primary and secondary healthcare services in Neno district [31–33]. APZU has also strengthened the district's HMIS data and systems by providing necessary stationery, conducting data quality assessments, and training HMIS statistics clerks. Between 2020 and 2022, APZU together with MOH conducted four DQAs in Neno district to improve data consistency between registers, reports and DHIS2 across 15 health facilities. While studies have been done on DHIS2 data quality in Malawi, mostly have focused on completeness and timeliness, none have focused explicitly on data consistency and none has been done in Neno district [12, 18, 25, 27, 28]. We aimed to describe data completeness and timeliness at the national level, South West Zone and Neno district. Further, describes data consistency following DQA in Neno district.

Methods

Study design

We conducted a descriptive study in Neno district, Malawi utilizing DHIS2 data from January 2016 to December 2022. The study period was chosen based on the DHIS2 system. Malawi's DHIS2 has undergone several system upgrades, achieving a stable version from 2016 onwards, with minimal instances of data loss [34].

Study settings

Our study was conducted in Malawi, focusing on Neno district, located in the southern part of the country under the SWZ. South West Health Zone has seven districts: Blantyre, Chikwawa, Chiradzulu, Mwanza, Neno, Nsanje and Thyolo. Neno is home to approximately 153,132 individuals, according to the 2023 mid-year National Statistical Office estimates [35]. Most areas in Neno lack tarmac roads, which makes it challenging to access during the rainy season. The district has 15 health facilities (two hospitals and 13 health centres) that provide primary and secondary care services The district is divided into two distinct terrains. The western region is mountainous, characterized by the Kirk-Range mountains [36]. Neno District Hospital and six health centres

(Matandani, Nsambe, Dambe, Neno Parish, Ligowe, and Magaleta) are situated there. On the other hand, the eastern side is a flat land that stretches along the Shire Valley. Lisungwi Community Hospital and seven health centres (Midzemba, Matope, Zalewa, Nkula, Tedzani, Chifunga, and Luwani) are located in this area. Tedzani facility is co-managed between Neno and Blantyre District Health offices (Fig. 1).

Sampling strategy and data quality assessments

We targeted all 1266 functional health facilities at the time of data extraction across Malawi that report using DHIS2 grouped at three levels: National level, South West Health Zone and Neno district. In addition, we targeted all active reports for completeness and timeliness (Table 1).

We excluded all reports that were not active or unavailable in DHIS2 before 2016 or were only available at Central Hospitals, including COVID-19, Ophthalmology, School Health and Nutrition Services, Leprosy and Dental reports.

In this study, we defined report completeness as those reports available against those expected in a specified time. Report timeliness as all those reports entered into
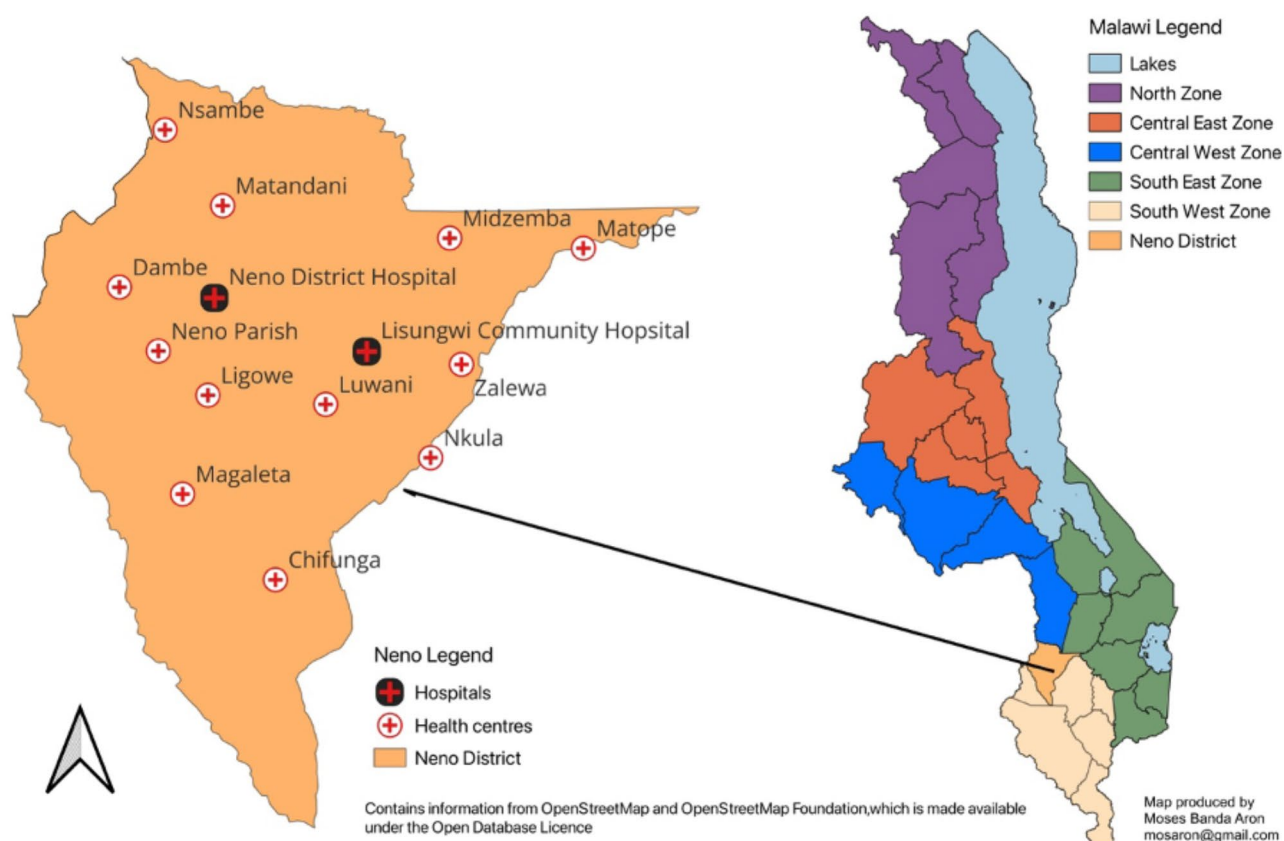
Fig. 1 Map of Malawi health zones and Neno district with health facilities

Table 1 DHIS2 reports considered for completeness and timeliness

Program	Report	Abbreviation	Frequency
	Integrated Disease Surveillance Report	IDSR	Weekly
Community Heath	Community-based maternal and newborn care	CBMNC	Monthly
	Integrated Management of Childhood Illnesses	IMCI	Monthly
General Services	Blood Safety		
	Health Management Information System	HMIS-15	Monthly
	Integrated Diseases Surveillance Response	IDSR	Monthly
	Malaria		Monthly
	Social and Behavior Change Communication	SBCC	Monthly
	Skin		Monthly
Maternal Neonatal and Child Health	Antenatal Care	ANC	Monthly
	Expanded Program on Immunization	EPI	Monthly
	Helping Baby Breathe	HBB	Monthly
	Kangaroo Mother Care	KMC	Monthly
	Maternity		Monthly
	Maternal and Neonatal Death	MND	Monthly
	Postnatal Care	PNC	Monthly
Non-Communicable Disease and HIV	Exposed HIV Program	Exposed HIV	Monthly
	HIV testing and Counselling	HTC	Monthly
	Mental Health	MH	Monthly
	Palliative	Palliative	Monthly
Nutrition	Community-based Management of Acute Malnutrition	CMAM	Monthly
	Nutrition Care, Support, and Treatment	NCST	Monthly
	Nutrition Rehabilitation Units	NRU	Monthly
	Outpatient Therapeutic Program	OTP	Monthly
	Supplementary Feeding Program	SFP	Monthly
Sexual Reproductive Health Rights	Community-Based Distribution	CBD	Monthly
	Cervical Cancer	CC	Monthly
	Family Planning	FP	Monthly
	Sexually Transmitted Infection	STI	Monthly
	Voluntary Male Medical Circumcision	VMMC	Monthly
	Youth Friendly Health Services	YFHS	Monthly
HIV, Tuberculosis and Non-Communicable Diseases	Antiretroviral Therapy	ART	Quarterly
	Non-Communicable Diseases	NCD	Quarterly
	Tuberculosis case finding	TBCF	Quarterly
	Tuberculosis Multi-Drug Resistant	TBMDR	Quarterly
	Tuberculosis treatment outcome	TBTO	Quarterly
	Tuberculosis-HIV treatment Report	TBHTR	Quarterly

DHIS2 before the set deadline. Lastly, consistency was defined as the level of agreement between the source register, compiled report and DHIS2 system. The Central Monitoring and Evaluation Division of the Malawi Ministry of Health considers a weekly report as timely when it is entered into DHIS2 by Monday 5:00 pm for the preceding week, considers monthly reports timely when it has been entered into the DHIS2 by the 15th of the following monthly and similarly, quarterly reports timely, when it is entered into DHIS2 by the 15th of the next month after the quarter [17, 25]. The district adopted the national targets for completeness and timeliness set at 85% for all reports [25].

For data consistency in DHIS2, we focused on the 15 health facilities in Neno district, where four DQAs were conducted between January 2020 and December 2022. The DQAs targeted various programs, and the findings were presented to the joint review meetings by the PIH/APZU management and the Neno District Health Management Team (DHMT), including program leads, coordinators and the HMIS team. In each meeting, challenges and opportunities were discussed, and action items were later implemented. From these meetings, a systematic report monitoring was commissioned and efforts were put in place to follow up on delayed reports and also remind facilities to submit reports on time. The data elements to be assessed for consistency of the next DQA were determined during the meeting which kept changing from one DQA to another. Further, for all programs, two data elements were selected during the meeting

based on the feasibility in terms of time, costs, and workload among others. While this approach ensured that all programs were represented and their data were checked, temporal trends could not be established.

Data collection
We extracted secondary data on weekly, monthly and quarterly report completeness and timeliness rates from the District Health Information System (DHIS2) at three levels: Neno district, South West Zone, and the national

Table 2 DHIS2 data elements included in the 2020–2022 DQA consistency in Neno District

DQA round	Report	Data element	Description
First July – September 2020	Helping baby breath (HBB)	Number of babies resuscitated	All babies that are born asphyxiated are supposed to be resuscitated. The number in the HBB register should match the number on the HBB report and in DHIS2.
	Kangaroo Mother Care (KMC)	Number of babies initiated on kangaroo	Babies that are born prematurely receive KMC services and are recorded on the KMC register, matching those on the report and DHIS2.
Second January – March 2021	Malaria	Number of confirmed malaria cases (outpatient)	All people that are tested and confirmed to have malaria are recorded in the Outpatient register and should match those on the report and in DHIS2.
	Expanded Program on Immunization (EPI)	Number of children under one who fully immunized	Children aged less than one year that are fully immunized are documented in the under one register of which should be the same on the EPI report and in DHIS2
Third October – December 2021	Maternity	Number of babies with asphyxia	All babies that are born asphyxiated are reported in the maternity register. The number in the register should match the number on the report, and in DHIS2.
	Youth Friendly Health Services (YFHS)	Number of teen pregnancies aged 15-19 years	All pregnant teenagers 15-19 years who come for antenatal care services or post-abortion care are documented in the antenatal register. This should be the same on the Youth Friendly Health Services report and DHIS2
Fourth April – June 2022	Tuberculosis (TB)	Number of pulmonary TB cases registered	All TB registered should be documented in the register and should be the same on the report and in the DHIS2.
	Nutrition	Number of new admissions wasted (children aged 6-59 months)	All children that are wasting are registered into the program; this number should be the same on the OTP and NRU register, report and DHIS2

level. Due to a DHIS2 technical system error, we only managed to extract data from January 2018 for quarterly report timeliness and completeness. We further collected primary data for four data quality assessment reports in Neno district between 2020 and 2022 to assess the data consistency. These were numbers for each data element from the health facility register, reporting form and DHIS2 for three consecutive months. We selected two data elements for each round of DQA (Table 2).

Data analysis
We used Excel and R version 4.1.1 to clean and analyse the data. We presented the data graphically and calculated yearly median reporting rates to describe yearly trends at the Neno district level, South West Zone and nationally for weekly, monthly and quarterly reports' completeness and timeliness. To evaluate data consistency, we used a well-known procedure in DQA [15, 37, 38] known as a verification factor on a 0-200% scale and compared information from the register with the data documented in the report and entered into DHIS2. A verification factor exceeding 100% indicated over-reporting, while a factor of 100% suggested a perfect match, often rare, and a factor below 100% indicated under-reporting. To determine the acceptability of the data, we applied a routine data quality assessment scale where a range of 90 -110% was considered acceptable, reflecting a 10% tolerance from a perfect match. Any values falling outside this band indicated either over-reporting or under-reporting [37].

Results
IDSR weekly report completeness and timeliness rates at national, zonal and Neno district levels
At all three levels, there was an increasing trend in the completeness of the weekly reports with a drop in 2020 for SWZ and at the national level. The yearly median completeness rates were above the target of 85% for the Neno district from 2020 to 2022. For report timeliness, while increasing trends were observed at all levels, it was less than the set target of 85% (Fig. 2).

Monthly reports completeness and timeliness rates at national, zonal and Neno district levels
Overall, median yearly reporting completeness rates increased at the national, southwest zone and Neno district during the study period with a lower than the set target. Neno district surpassed the set target of 85% in 2019 (Fig. 2). Similar trends were observed for individual monthly reports (Fig. 3).

For timeliness, the yearly median report timelines rates increased in the study period but were below the target except in 2022. Similar increased trends were observed
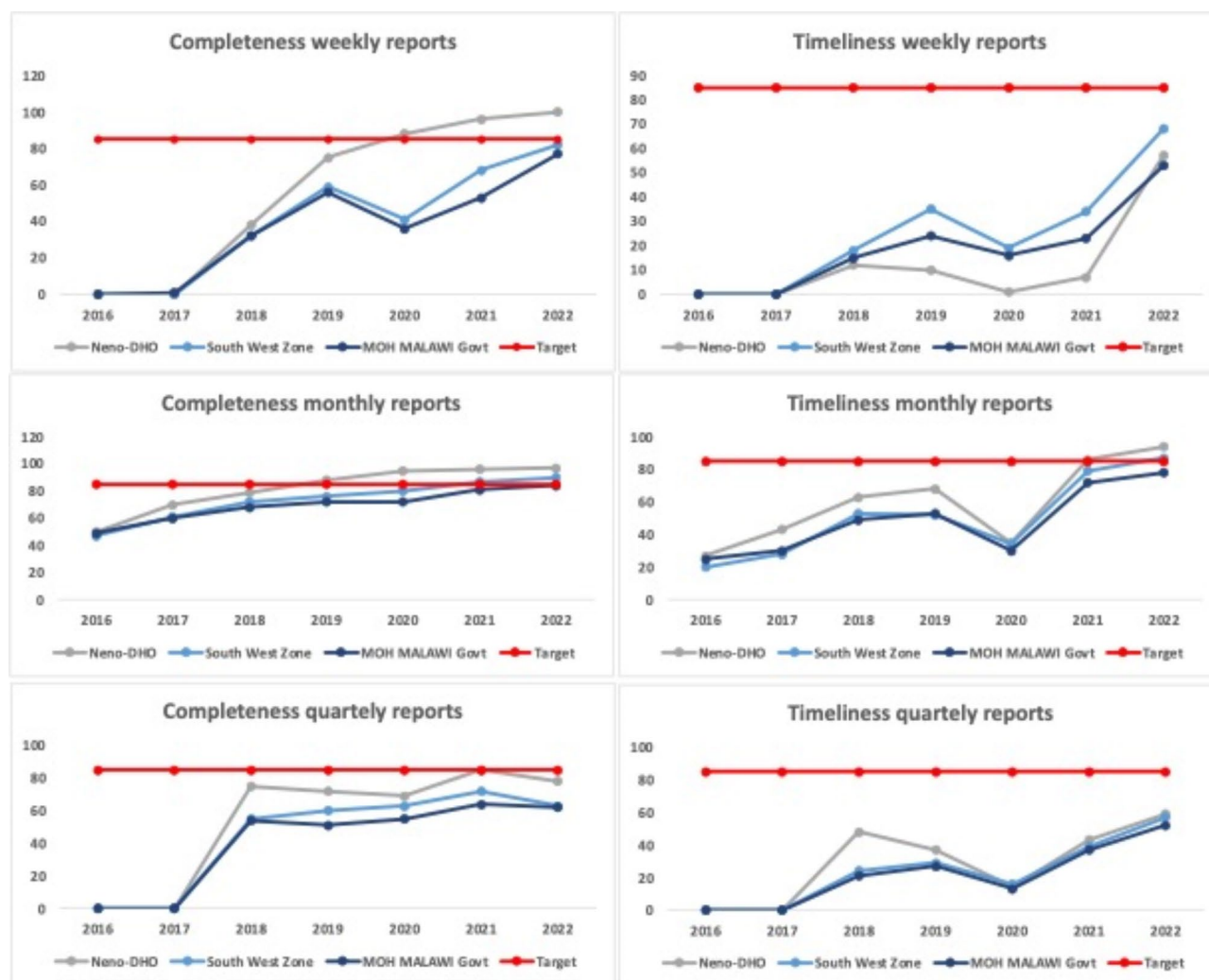
Fig. 2 Yearly median completeness and timeliness rates between 2016 and 2022

in individual monthly reports with a substantial drop between March 2020 and August 2020 (Fig. 4).
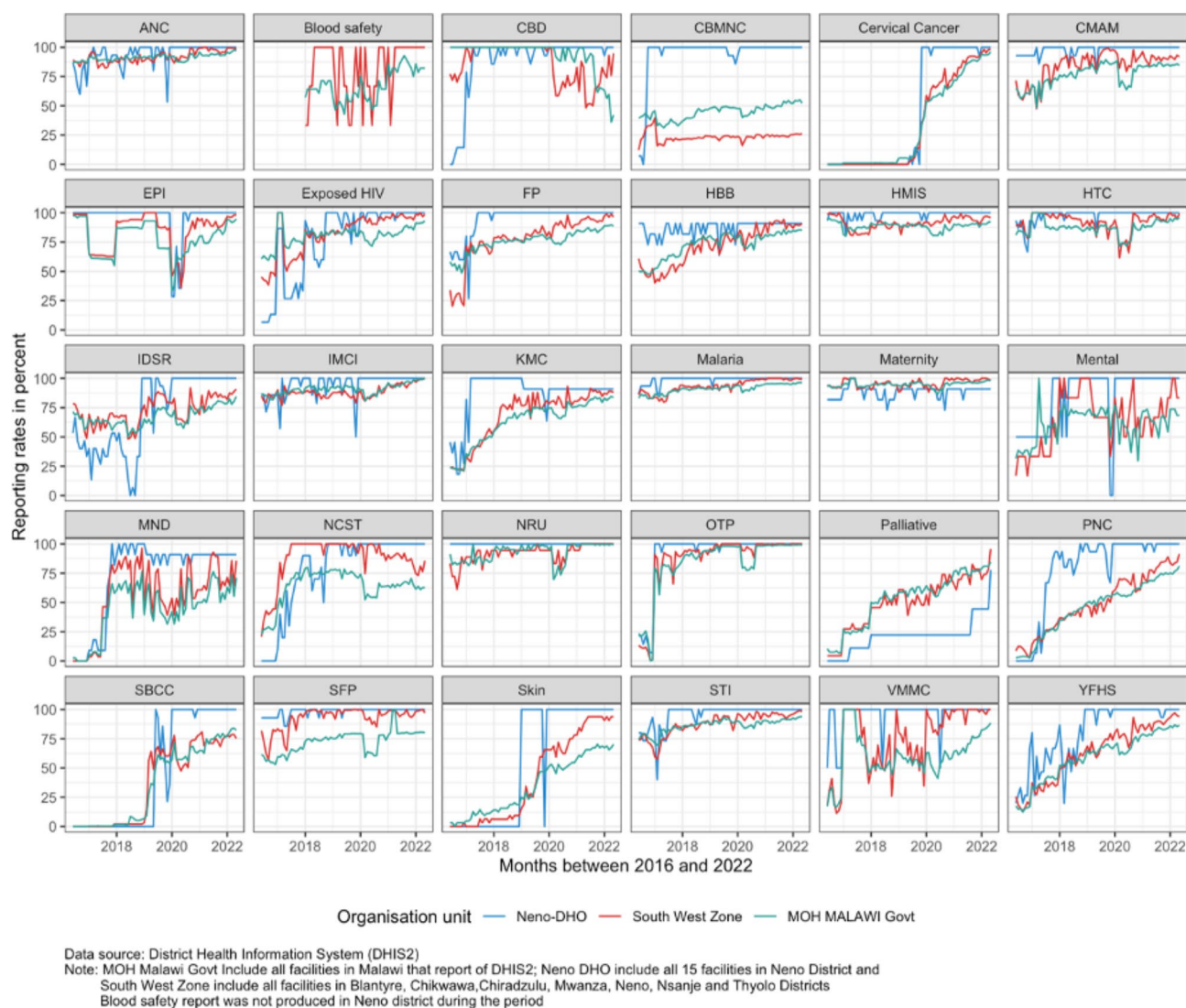
Quarterly reports completeness and timeliness rates at national, zonal and Neno district levels

We observed increased trends in both timeliness and completeness of quarterly reports between 2016 and 2022 for the national level, SWZ, and Neno, however, all the median yearly rates were below the set target of 85% (Fig. 2).

Data consistency in Neno district

We found that the number of babies initiated on Kangaroo Mother Care (KMC) was reported within a tolerable range from the register to the report (VF: >90% - <110%). However, there was a significant under-reporting of KMC cases to DHIS2, with a VF of 39% of the cases being recorded. Regarding the number of babies resuscitated, the report perfectly matched the records in the Helping

Babies Breathe (HBB) register. However, similar to KMC, resuscitated babies were under-reported to DHIS2. There was under-reporting of the number of babies born with asphyxia between the report and the register and the report and DHIS2 (VF: <90%). There was an under-reporting from the register to the report regarding fully immunised children. Surprisingly, the report to DHIS2 showed overreporting, reaching up to VF of 119%. Malaria-confirmed cases and teen pregnancies were reported accurately from the register to the report and DHIS2 (VF: >90 -110%). There was over-reporting of pulmonary TB cases registered and the number of wasted malnourished children aged 6–59 months between register and DHIS2 (VF: >110%). Overall, while there were fewer discrepancies in the transfer of information from the report to DHIS2, a significant amount of over-reporting (25%) and under-reporting (50%) was observed between the register and the report, creating

Data source: District Health Information System (DHIS2)
Note: MOH Malawi Govt Include all facilities in Malawi that report of DHIS2; Neno DHO include all 15 facilities in Neno District and
       South West Zone include all facilities in Blantyre, Chikwawa, Chiradzulu, Mwanza, Neno, Nsanje and Thyolo Districts
       Blood safety report was not produced in Neno district during the period

Fig. 3 Monthly completeness by type of report

huge discrepancies between the registers and DHIS2 in return (Fig. 5).

Discussion

During the study period, we found increased trends in weekly reports' completeness and timeliness at all three levels but overall were below the set target of 85%. This was also observed in monthly and quarterly report completeness and timeliness. For data consistency, while we found a few discrepancies when between a report and DHIS2 (VF: >90% and <110%), a significant amount of over and under-reporting occurred between the register and the report. As a result, substantial discrepancies arose between the registers and DHIS2.

Generally, an increased trend in the completeness of weekly and monthly DHIS2 reports was observed from 2016 to 2022 at the three levels and even higher rates in

Neno district surpassed the target in 2019 and 2020 for monthly and weekly reports respectively. This could be explained by recent efforts by the Ministry of Health to improve data throughout the country and for Neno, close data monitoring through follow-up of delayed reports and data quality assessment [20–22]. However, more efforts are needed as our findings show that in general, all were below 85% threshold. Our findings are similar to studies in other districts across the country that assessed DHIS2 data for completeness and timeliness [25, 28]. We further observed a drop in 2020 across the report's timeliness and completeness; this could be attributed to COVID-19, which affected services across the country, including the HMIS office, as reported by other studies [39–41]. Between March 2020 and August 2020, a DHIS2 system failure occurred in Malawi, potentially impacting the reporting rates and data within the system.

Fig. 4 Monthly timeliness by type of report

Comparable instances of data loss resulting from DHIS2 system upgrades or failures have been documented in Ethiopia and Uganda [10, 42, 43].

For Neno district and Malawi to surpass the WHO target of 85% in report completeness and timeliness in DHIS2, various innovative ideas should be implemented. Some studies have proposed decentralizing DHIS2 data entry to the point where reports are generated, necessitating proper training and knowledge for healthcare workers responsible for compiling the reports, fostering collaborative partnerships with multiple stakeholders, enhancing HMIS financing, and conducting regular monitoring and supervision, among other measures [7–12]. In November 2022, Neno district initiated the decentralization of DHIS2 to health centres in a step-wedge process. Further research is required to assess the effectiveness of decentralisation and identify potential areas for refinement and enhancement.

While our findings indicated minor challenges in data entry to DHIS2, over and under-reporting occurred between the register and the report observed (VF: <90% and >110%) in Neno district. This has serious implications for using the data in decision-making at all levels. For example, the low number of babies with asphyxia in DHIS2, while the register had more, would impact the resources allocated to the program. Our findings of the discrepancies between DHIS2 and the register have been reported in other settings on various indicators, including Malaria, immunizations, facility delivery and antenatal visits, among others [9, 44, 45]. In the quest to improve data consistency and reporting in Neno district, training was provided to all statistical clerks responsible for data entry in DHIS2 and healthcare workers in the maternal and child health program. However, additional research is needed to explore the contextual factors contributing to both under-reporting and over-reporting and other
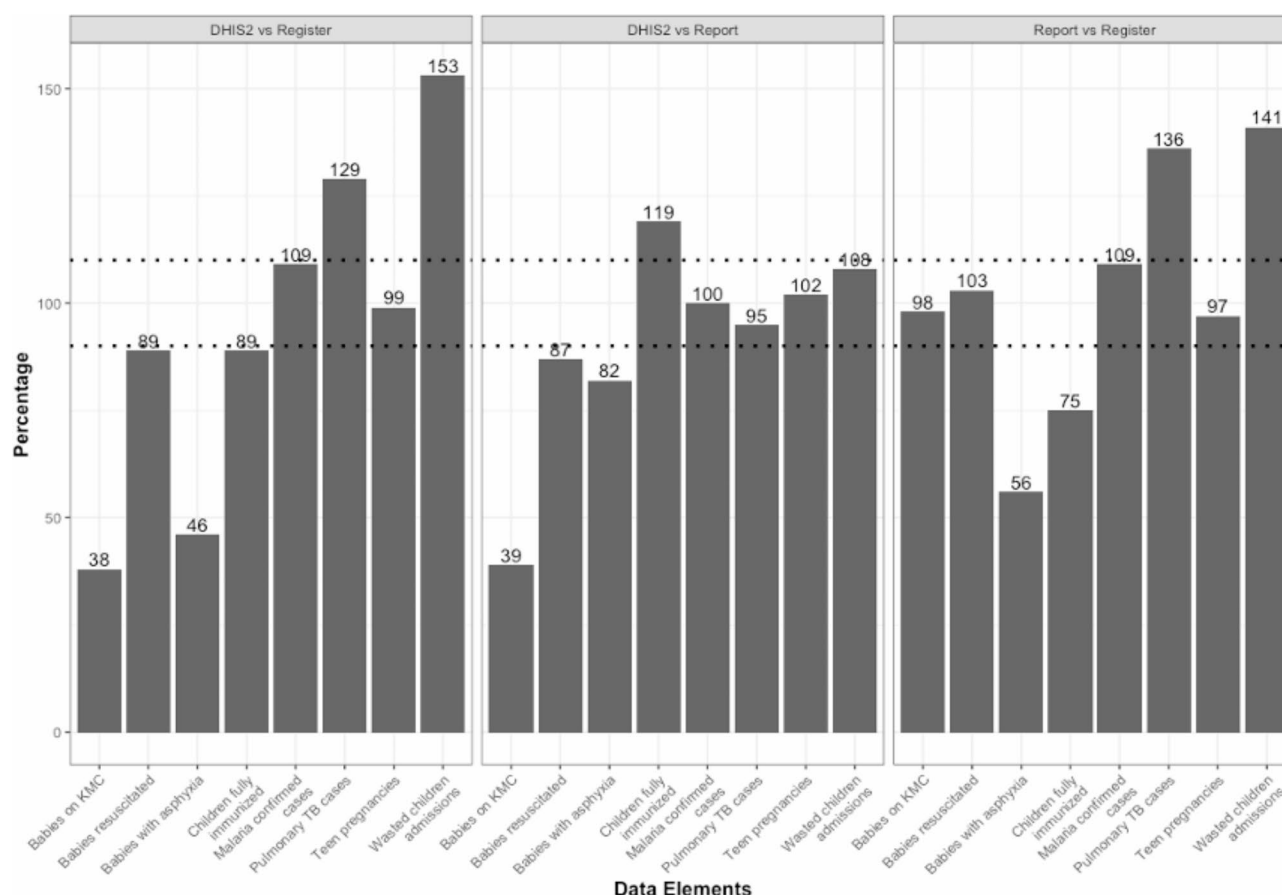
Fig. 5 Data verification results for Neno district

data quality metrics beyond the scope of those examined in our study. Further studies should also explore the internal consistency of data in DHIS2 using a comparison of indicators collecting seemingly the same information.

Our study strength relies on three key aspects: first, using DHIS2 at three levels: national, SWZ, and Neno district levels and secondly, analysing reporting rates for almost all the reports in DHIS2 and finally, assessing consistency across several data elements from various programs in Neno district. However, it has some notable limitations, including generalizability on data consistency, as it was only assessed in Neno district, a typical rural district in southern Malawi and may not represent the other districts. Furthermore, it's plausible that additional collaborators or stakeholders within Neno district are also playing a role in enhancing the data quality in DHIS2 and therefore, we can not attribute our findings to these DQAs and systematic report monitoring. However, investigating their contributions falls outside the scope of this study. DHIS2 calculates the completeness and timeliness rates. As such, any errors in system programming that may affect these calculations are beyond the scope of this paper. However, to minimise such errors, we also extracted the number of reports available against those

expected, this only worked for completeness and not timeliness. Within our study period, the DHIS2 system experienced a failure between March 2020 and August 2020. However, an assessment of how this affected the data in the system is outside the scope of our study.

Conclusion

Our study demonstrated increased DHIS2 weekly and monthly report completeness and timeliness rates at all three levels: Neno district, SWZ and the national level, however, were below the set target of 85% in general. Neno district surpassed the 85% set target for monthly reports from 2019 and weekly reports from 2020 onward. We found substantial discrepancies between the registers and DHIS2 in the Neno district. We suggest continued support, including routine DQAs and report monitoring towards improving DHIS2 data quality and further research on other data quality dimensions not assessed in our study.

Abbreviations
DHIS   District Health Information Systems
HMIS   Health Management Information System
DQA   Data Quality Assessments
SWZ   South West Health Zone

VF	Verification Factor
ANOVA	Analysis of Variance
LMICS	low- and middle-income countries
SSA	Sub Saharan Africa
PHC	Primary Health Care, MOH: Ministry of Health
CMED	Central Monitoring and Evaluation Division
APZU	Abwenzi Pa Za Umoyo
DHMT	District Health Management Team
NHSRC	National Health Sciences Research Committee
WHO	World Health Organisation

Author contributions
MBA, WN, and FM conceptualized and designed the study. WN, MC, IM and KM facilitated data collection. MBA and SC analysed data. MBA drafted the manuscript with initial major reviews from LD, CK, FM, GMB, BM and KMpinga. All authors reviewed the manuscript, provided input, and suggested additions and changes where needed. All authors read and approved the final manuscript.

Data availability
The datasets generated and/or analysed during the current study are available in the Zenodo repository: https://doi.org/10.5281/zenodo.8246099

Declarations

Ethical approval
The study received ethical approval from the Malawi National Health Sciences Research Committee (NHSRC Protocol # 22/06/2866 dated: 9 June 2023) with an institution support letter from Neno District Health office. No consent was obtained as the study used secondary data from DHIS2, reports and registers.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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