

Immunization data quality and factors influencing data generation, handling and use in Wogera District, Northern Ethiopia, 2020

Tesfahun Hailemariam Madebo^{1#*}, Lemma Derseh Gezie^{2#}, Alemayehu Teklu³, Zeleke Abebaw Mekonnen⁴, Asm Shahabuddin⁵, Binyam Tilahun¹

Abstract

Background: Data quality is a vital metric in health information systems to ascertain improved health of individuals and community as well. Immunization data are critical inputs in assessing national performance of expanded program on immunization and child health improvement. Inconsistent health data happens when variations arise in the report and re-count from the source documents.

Aim: This study aimed to assess immunization data quality and factors influencing data generation, handling, and use.

Methods: Both qualitative and quantitative data were used. Immunization recording and reporting documents were reviewed at 41 health facilities of primary health care units. Twenty health workforces were interviewed on healthcare data quality, generation, handling, and use. The Statistical Package for the Social Sciences (SPSS) for windows version 26 was used to perform quantitative data analysis and open code version 4.02 was used for qualitative data analysis. Data accuracy was presented using mean and standard deviation of data verification factor.

Results: Over-reporting of immunization data elements was observed. The highest accuracy (75%) was reported for full immunization at health center level followed by 62.5% for measles. The difference between verification factor of ideal reports and observed values, indicates that there is over reporting in all immunization data elements by 44% (27-61%), 46% (=31-61%), 40% (12-61%), 37% (11-63%), and 38% (12-64%) in BCG, Penta 1, Penta 3, measles, and full immunization, respectively. Supervision, availability of recording and reporting tools, training, motivation, attitudes towards healthcare data, hard to reach areas and manual documentation were influencing factors of immunization data quality, generation, handling, and use.

Conclusion: The study revealed that health facilities over-reported immunization data elements in primary health care units. Attentions should be given to address organization, behavioral, technical, and contextual factors influencing immunization data quality, generation, handling, and use. [*Ethiop. J. Health Dev.* 2021; 35(SI-3):56-64]

Keywords: Immunization data quality, Factors influencing, Verification factor, Wogera district

Background

Healthcare data quality determines the health status of individuals and society and helps to inform proper decision making and improvement. Inconsistent health data happens when the report and re-count from the source documents become mismatched (1). Health facility data are indicators that help to evaluate national health program's performance (2). Though routine Expanded Program on Immunization (EPI) data quality is vital, to inform policy and decision making, there is high variation in EPI data reports and registers (3, 4). Timely and reliable EPI data is deemed necessary to bring about a change in healthcare, however, it is not given the required attention and importance that it deserves (5). Poor data quality is considered as an impeding factor of EPI performance in healthcare settings (6). EPI program performance and quality data generation challenges are still present to date since the inception of EPI programs in 1974 (7-9).

Evidence shows inconsistencies between reported and registered data as one of the core challenges in EPI data management practices (10). Inadequate support systems from higher levels, lack of standards for data verification, political pressure for data breaching, lack of awareness of health professionals about EPI data

handling, lack of trained personnel in routine EPI programs, workload and less motivated health professionals in the area, infrequent feedback mechanisms, skill gaps on health management information systems, and organizing and reporting of health care data are all barriers of EPI program performances, including its quality data generation, handling, and use (11-17). Inconsistent and false reports could bring about devastating outcomes in health systems, as healthcare data are important resources in clinical and public health practices (18).

Generation of high EPI data quality depends on the exploration of existing situations (19) through monitoring routine EPI data quality (1). Developing the level of confidence in EPI data by optimizing the extent of presenting proper data management practice in healthcare facility is essential (2).

Health system data quality improvement is one of the four health sector transformation agendas in Ethiopia (20). Consistency, both in registers and tallies, reports and source documents are important concerns to ensure good EPI data management practices. EPI indicators are crucial in improving the child's health status, as is planning and decision-making, which is likely to be data

^{1#*}Department of Health Informatics, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia.

^{2#}Department of Epidemiology & Biostatistics, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia

³Department of Pediatrics and Child Health, University of Gondar, Gondar, Ethiopia

⁴Health System Strengthening Directorate, Ministry of Health, Addis Ababa, Ethiopia

⁵Primary Health Care-Health Systems Strengthening Unit, UNICEF New York, USA

Equal contributors *Corresponding author

driven. However, good EPI data generation, handling and use are still unresolved challenges in primary health care units.

To the best of our knowledge, factors hindering EPI data generation, handling, use and perceptions of health professionals towards immunization data quality and factors influencing data generation, handling and use have not been assessed in the area. Therefore, this study aimed to assess EPI data quality and barriers of good EPI data generation, handling, and use. A Mixed methods study design was used to explore the current data generation, handling and use practices in primary health care at the unit level. Furthermore, this study aimed to explore hindrances of good EPI data generation and could help promote improved data which in turn can inform future health initiatives aimed at individual and community levels.

Methodology

Study area: The study was conducted in the Wogera district, Northwest Ethiopia in 2020. It is 220 Kms away from the capital city of Amhara regional state. The district has 51 Kebeles. The total population of the district is about 278,942. There is 1 primary hospital, 8 health centers, and 41 Health posts (Health posts) in the district which provides preventive, promotive and curative services. Regarding the health work forces, there are 98 health extension workers, 678 health workers, and 215 administrative staff.

Study design: A mixed methods approach was utilized for this study. Quantitative cross-sectional record review and phenomenological qualitative study designs were carried out for assessments. Accordingly, verification factor, percentage and frequency were utilized for quantitative part of the study and thematic content analysis was used for the qualitative aspect of the study.

Sample: Immunization records of all public health facilities under primary health care units which report health data to respective levels. Health Management Information System (HMIS) officers, EPI focal persons, Health Extension Workers (HEWs), and Health Center heads were considered as the key informants for the qualitative interviews conducted in this study.

Inclusion criteria: For document review, facilities under primary health care units that have been reporting for more than one year were selected and records and reports from respective facilities were reviewed. For qualitative interviews, HMIS officers, EPI focal personnel, HEWs, and Health center heads who have been working on health systems for more than one year were interviewed.

Sample size: For record review, facility census was used in all primary health care units in the district. In qualitative assessment, twenty key informant interviewees (5 from Health centers, 5 from EPI units, 5 from HMIS offices, and 5 from Health posts) were purposely selected. Sample size of the interviewees was determined by information saturation, where there are no new emerging ideas observed. Participants were

recruited considering their previous experiences in data management practices.

Variables of the study:

Data accuracy: For accuracy of immunization data indicators, data on report and registration book (tally/family folder) on BCG, Penta 1, Penta 3, Measles, and full immunization was investigated.

Reliability: Refers to the data in the reports being consistent with registers and tally sheets according to the WHO level of tolerance for data quality with $\pm 10\%$ variation.

Completeness: Denotes that all required data elements are present in registers, tally sheets, family folders and reporting tools.

Timeliness: When the report arrives at the health centers every 23rd day of the month from health post to health centers and from the 24-26th day of the month from health centers to woreda health offices.

Data management practices: Data generation, completeness, archiving, reporting and utilization

Data collection tools and procedures

Data collection tools were developed by reviewing literature related to data quality and factors affecting, generation, handling, and use. The tool was piloted prior to data collection commencing. To investigate reliability of immunization indicators, data from the reports and registration books (tally/family folder for health post), from fourth quarter of 2011 to third quarter of 2012 Ethiopian fiscal year, was analyzed using a structured checklist. To examine factors influencing immunization data quality, purposely selected key informants (HEWs, EPI focal, HMIS officers and Health center heads) were interviewed on immunization data management practices, behavioral (skill and motivation), organizational (availability of recording and reporting tools, training, and supervision), technical (process of documentation) and contextual related factors (hardship area). Semi-structured in-depth interview guidelines were used to facilitate qualitative data collection processes. In addition, tape records were used to capture audio data after obtaining oral consent from participants. The data was collected by health informatics and public health professionals.

Data organization and analysis

Data collectors and supervisors were trained on both quantitative and qualitative tools. Data was examined daily for the completeness and consistency by the supervisors in the field. Each copy of the checklist filled with data was checked for completeness and data entry and analysis were performed using SPSS version 26 statistical software. The qualitative data was transcribed to original language used for data collection (Amharic) and translated to English and then coded and organized thematically using open code version 4.02 software.

Descriptive statistics was used to analyze immunization data quality. Categorical variables were described using actual numbers and percentages and presented using

tables and figures. Continuous variables were described by means, standard deviations, minimum, and maximum. Confidence interval (CI) for mean of each data element was computed using open Epi version 3.01 at 95%CI.

Ethical Consideration

Administrative health units were informed through an official letter before the data collection commenced. Letter of ethical clearance was obtained from Institutional Review Board (IRB) of University of Gondar. Supportive letters were obtained from Amhara regional Health Bureau, from central Gondar Zone health department, Wogera woreda Health Office, and from health centers under woreda health office. The participants were informed about the privacy, confidentiality and security issues of their information that would be maintained and used only for the intended

purpose. Oral informed consent was obtained from participants during the in-depth interview.

Results

A total of 41 health facilities were included in the study to investigate the reliability of immunization data indicators quantitatively. Specifically, all 8 health centers and 33(86.8%) health posts were part of the study. A total of 20 health workforces were involved in the in-depth interview to explore the immunization data management practices and factors influencing the generation, handling, and utilization of quality immunization data.

In the current study, the accuracy of the report was 75% for full immunization, 62.5% for the measles report, 50% for each of the BCG and the penta1 vaccines, and 25% for penta3 in health posts. Similarly, for Penta 1, it was 36.4%, 30.3% for each of Penat3 and measles for the health posts (Figure 1).

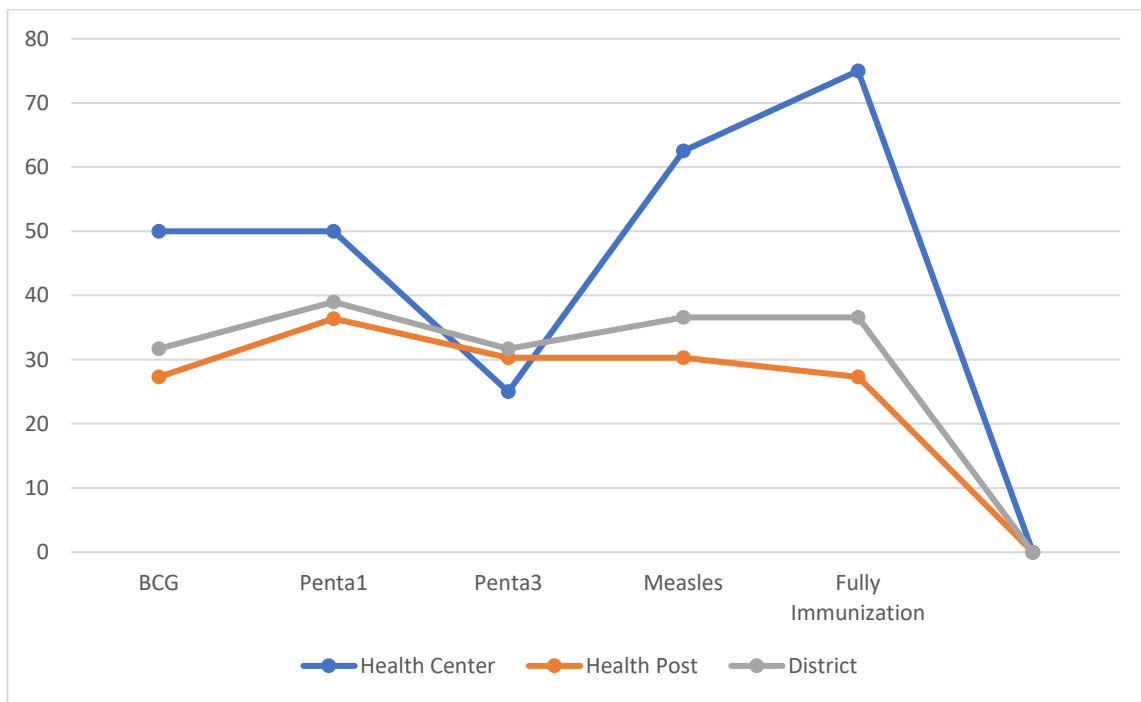


Figure 1: Proportions of facilities reported immunization indicators accurately

Verification factors

The verification factors were computed to examine the consistency of reports at primary health care units. According to the study, immunization data reports were manipulated, showing verification factors up to 4.5 (mean 0.63 ±0.86) for measles and 4.5 (mean 0.62 ± 4.5) for full immunization at woreda level. At the health

centers, the variations between reported and recounted were observed to be 4.5(1.57±1.44) and 4.5 (1.67±1.32) for measles and full immunization, respectively. At health post level, a verification factor of 1.05 (0.37±0.43) was observed for the full immunization report (Table 1).

Table 1: Verification factors with mean and standard deviation with maximum and minimum reports in Wogera District, 2020

Indicators

Facilities	Statistics	BCG	Penta 1	Penta 3	Measles	Fully Immunization
Health center	Mean	1.105	0.95	1.35	1.57	1.67
	Std. Deviation	0.63	0.41	1.03	1.44	1.32
	Min-Max	0.00-2.33	0.00-1.40	0.00-3.00	0.00-4.50	1.00-4.50
Health posts	Mean	0.42	0.45	0.38	0.40	0.37
	Std. Deviation	0.45	0.46	0.44	0.44	0.43
	Min-Max	0.00-1.06	0.00-1.04	0.00-1.02	0.00-1.00	0.00-1.05
Woreda	Mean	0.56	0.54	0.60	0.63	0.62
	Std. Deviation	0.55	0.49	0.70	0.86	0.86
	Min-Max	0.00-2.33	0.00-1.4	0.00-3.00	0.00-4.5	0.00-4.5

The mean verification factor (VF) with its standard deviation (SD) showed that all immunization indicators

were out of 10% precision range except penta1 at health center level as presented in Table 2.

Table 2: Comparison of mean and standard deviation with 10% precision level

Facilities	statistics	Indicators				
		BCG	Penta 1	Penta 3	Measles	Fully Immunization
Woreda	Mean	0.56	0.54	0.60	0.63	0.62
	SD	0.55	0.49	0.70	0.86	0.86
Health Center	Mean	1.12	0.95	1.35	1.57	1.67
	SD	0.63	0.41	1.03	1.44	1.32
Health Post	Mean	0.42	0.45	0.38	0.40	0.37
	SD	0.45	0.46	0.44	0.44	0.43

The difference between verification factors of ideal report and observed report (1-VF) indicated that immunization data elements, such as BCG, Penta1, Penta3, measles, and full immunization had positive

figures, indicating 44%, 46%, 40%, 37%, and 38% for BCG, Penta1, Penta3, Measles, and full immunization respectively (Table 3).

Table 3: Overall mean verification factors of immunization indicators and deviations from ideal value, Wogera District, 2020

Immunization elements	data	Statistics					
		Min	Max	Mean of VF	SD	(1-VF)	95%CI of VF
BCG (n=41)		0.00	2.33	0.56	0.55	0.44	[0.27, 0.61]
Penta 1(n=41)		0.00	1.4	0.54	0.49	0.46	[0.31, 0.61]
Penta 3 (n=41)		0.00	3.00	0.60	0.70	0.40	[0.12, 0.61]
Measles (n=41)		0.00	4.5	0.63	0.86	0.37	[0.11, 0.63]
Full Immunization (n=41)		0.00	0.45	0.62	0.86	0.38	[0.12, 0.64]

In the qualitative part, twenty respondents were involved (5 HEW, 5 HMIS officers, 5 Head of Health centers, and 5 EPI focal persons). All respondents were interviewed in two pre-specified thematic sections and respective sub-themes.

Organizational factors

According to the study, health facilities face challenges in getting EPI data capturing and reporting tools in a timely manner from their respective higher levels. It is difficult to understand EPI data management practices unless organization factors are resolved in primary health care units. Health workers prepare local formats on their own when standard tools are unavailable in the cluster. One of the respondents explained this idea as follows, "We design the recording and reporting format by ourselves to capture children's data since we don't get registers and tallies regularly on timely manner. If we get quality format for data capturing in our cluster, quality data handling and utilization could come to practice." (F, 28, HEWs). Another respondent saying, "Absence of shelves, limitation for registers, tallies, and

reporting tools are the challenges we need it to be solved. Sometimes we use white papers to register clients on fields or on the day of vaccination campaign since we don't take registration book for field activity. We try to copy the data elements in registration book after field work. This kind of approach could affect the quality of the EPI data handling and need to be corrected" (F, 31, HEW).

Behavioral factors

Knowledge, skills, attitudes, values, and motivation of the health professionals are essential elements to collect and use quality EPI data. Findings of this study showed that some health professionals do not perform routine activities committedly. One of the respondents confirmed this by saying, "All of them around here are new and do not have good skill and knowledge on reporting and filling the data. I ask others from other HCs in addition of reading helpful documents to know more on these topics" (M, 28, EPI focal). Unless health professionals are motivated and focused on the job, they are supposed to do, it will be difficult to get complete,

and reliable EPI data which is useful for planning and decision making. A respondent said, *“Carelessness is one major challenge; they may not register on the date scheduled properly; whenever, there is some problem, may be security or other, health workers stop working, though they should have struggle and face the problem and do their routine task”* (M, 28, EPI focal).

Technical Factors

In the current study we found that health professionals provide EPI services without getting training on routine EPI programs. This finding was evidenced by one of the respondents as follows, *“I face challenge during service delivery as I haven’t got the training.”* (M, 28, EPI focal). Another respondent explained this by saying, *“Knowledge gap of HEWs, failing to give support to HEWs are challenges in our case. Of course, we and they are fresh to our duty. So, this is another challenge; neither we nor they took training, and that will be a challenge; we don’t get continuous support”* (F, 30, HMIS officer). Another respondent forwarded that some health care providers deliver routine services and capture EPI data without getting training on routine EPI service programs and health information management systems. Supporting this idea, a respondent said, *“I haven’t got any training on EPI program. I am delivering the service by my own motivation and updating myself by reading the manuals and asking others. I love the profession and I try to my best to help clients even by updating myself on what I don’t know. I get satisfaction by serving children. That is great to me, and I am happy on the service I am giving”* (F, 30, Nurse, EPI focal).

Contextual factors

According to the study, hard-to-reach areas, lack of transportation to reach remote clusters and delay in timely feedback conditions, were issues affecting routine EPI service delivery and data management practices. These finding was explained by one of the respondents as follows, *“Because of the setting where our HC is situated, there is poor vaccination data generation, so delivery of data is usually via message, the land scape or geography where our health facilities are situated has influences and understanding of the community about the significance of vaccination data is not that much good. If you order someone to do something, he/she would not respond accordingly, or would not bring timely, or would not bring at all.”* (M, 25, Heath Center Head). Another respondent added the following evidence on the aforementioned finding saying, *“The roads are with ups and downs and uncomfortable and even guiders are assigned to go with the health workers, they need per-diem, which entails another challenge. As a result of all these and others, there is great challenge to modernize the data we have”* (M,30, Heath Center Head). He added. *“...the gotts (smallest administrative unit in the kebele) are difficult to reach because of the current situations, as the HEWs are females, it is difficult to move across the gotts. After asking the kebele leader, we try to assign a person who can guide us during vaccination. However, because they have their own personal duties, it couldn’t go as we planned”* (M, 30, Health center head).

Completeness

All involved participants (HMIS officer, EPI focal, HC head and HEWs) responded to the data completeness component. Many of the participants responded to the data completeness properly (all required fields of data recording and reporting tools need to be filled); a respondent said *“First, I will prepare lot quality assurance technique and see the tally sheet, register, and report for consistency, and if all agree with each other, then we will consider them as complete”* (F, 30, HMIS Officer). However, a participant explained it as vaccination completeness i.e., completion of vaccines from BCG to measles second dose. One of the participants shared this idea by saying, *“EPI data completeness starts at birth. i.e., when a child receives all vaccines with recording his or her data elements in registers, tallies, and then reporting the data to health center so that we call this process as data completeness.”* (F, 28, HEW).

Timeliness

Though variations observed in understanding of deadlines of sending reports to higher levels, many of the respondents replied that health posts are expected to report to a health center on the 23rd of the month, and the health center to Woreda on the 24-26th of the month. Many of the participants explained that a timely report is an essential component to produce good data quality, which helps to access inputs from higher level, helps for monitoring, preventing vaccine wastage, helps to identify vaccinated children from unvaccinated children, and it is also an indicator of routine EPI service activities. Respondents also claimed that unless timely EPI reports are not sent to concerning bodies, the consequences could affect individuals and the community as well. One of the participants said, *“If EPI report delays, one problem is that it is difficult to identify those who are vaccinated and unvaccinated; the other is even if they performed their work properly, as far as it is not reported, it will be considered as they worked nothing”* (F,30, Head of Health center Head). If timely data do not arrive at the respective levels, it is difficult to harmonize quality data generation and use, as input and proving feedback delivery is based on the report made. The participant explained this by saying, *“If vaccination data is not sent, the status of that kebele will not be known. We don’t know whether children are vaccinated or not. Outbreaks may occur as far as there is unvaccinated child. For example, if a child is infected with measles, we do not know whether the infected child is vaccinated or not”* (F, 28, HEW).

Improper EPI data management practice

The findings from this study revealed, that if individuals couldn’t get proper services, incorrect planning and decision making, resource wastage, inability to identify vaccinated children from unvaccinated children, reemergence of vaccine preventable diseases could occur and affect the health status of the population. One of the respondents explained as *“It could consequence a big problem. First, vaccine related problems among children might occur. For example, if we report or record a child who didn’t receive BCG vaccine as s/he was as vaccinated, the first victim would be a child himself and the second individuals and the community*

would be affected in one or another way. As to me, it is better to avoid false data fabrication and reporting i.e., a child who didn't receive an antigen reported as s/he did and vice-versa" (M, 23, HMIS Focal). Good practice in EPI data handling could help to limit problems related with false reports at the individual and community level. One of the respondents saying, "Increase the rate of false report, revaccination could take place unless we don't have data on our hands. For example, if we give polio 0 without registering the data, we could give the same vaccine in the next appointment; this kind of misinformation could make a child a victim for revaccination" (F, 28, HEW). One of the participants added the consequences of improper EPI data management practice as follows, "It results to a serious problem. If the data elements are missed without filling in appropriate recording tools, planning and taking an action would be relied on a wrong data so that we couldn't get a solution for a problem and if poor EPI data handling is recognized, we couldn't identify children those who received the vaccine for their age and who didn't" (M, 28, Heald of Health Center).

Optimization of good EPI data generation, handling, and use

The finding indicated that some of the health professionals who were assigned to the EPI unit didn't get routine EPI services and health management information system training. According to the study, experience sharing, supporting EPI data management with technology, availing registers, tally sheets and standardized recording and reporting tools, supportive supervision, and motivating of health professionals could help to improve EPI data generation, handling, and use. One of the respondents said "It is good if health professionals who are working on EPI room get update training.

Training creates motivation for health care providers to perform the job, fills skill gaps, and helps to obtain updated information in programmatic area. However, the study revealed that health care providers deliver the services without getting adequate training on routine immunization service. One of the respondents assured this finding by saying, "She has not received any training on EPI data handling procedures, and we feel that this might affect EPI data management practice" (M,23, HMIS Officer).

Availability of immunization logistics and updated recording and reporting tools would help to facilitate improvement of the quality data generation, handling, and immunization service delivery. One of the participants said, "we have to register; then we have to order them to go to HP for vaccination, we have to register the data. If we do not have register, we don't know about the status of these children. So, if all these are corrected, then the vaccination data will be better" (F, 28, HEW). Relying on manual data handling approaches would not bring the anticipated outcome in EPI data quality improvement and improved health status, furthermore, advancing the existing manual EPI data handling mechanism could help to bring promising results in the area. One of the respondents saying, "Technology support is another important area to

improve EPI data so that it can be accessible when it needed" (M,28, Health center Head). Close supervision and monitoring are critical inputs to ascertain quality data generation and use. One of the respondents said, "Verifying EPI registers, tally sheets, and reports on each cluster to correct if there is any mismatch during supportive supervision is also a good way to optimize EPI data practice" (M, 28, Head of Health Center).

Discussion

In the current study, data accuracy, factors influencing quality data production, handling and use were investigated. The result showed that all health facilities (health center, health post and woreda) reported immunization data elements out of the acceptable range except penta-1 at health center level. Though the mean value of penta-1 within 10% precision fall is an acceptable range. The difference between verification factors of ideal reports and observed values indicated that there is over reporting in immunization data elements by 44% (95% CI =27-61%), 46% (95% CI=31-61%), 40% (95% CI=12-61%), 37% (95% CI=11-63%), and 38% (95% CI =12-64%) in BCG, Penta 1, Penta 3, Measles, and fully immunization respectively. Generation, handling and use of healthcare data is vital for better planning and decision making that in turn help to improve individual and community outcomes (29-31). Unavailability of recording and reporting tools, inaccessibility of accurate data, organizational, behavioral, technical, and contextual factors are mainly considered to affect immunization data quality, its generation and use. According to the study, supporting EPI data management practices through information communication technology, creating motivation among health professionals, developing strong inter-facility linkage, developing best experiences sharing practices, supportive supervision, and provision of timely feedback could optimize good EPI data management practices and use. Inconsistency between reports and records in the current study might be due to negligence, lack of awareness of personnel in-charge on proper immunization data handling and use. The findings of this study are in-line with a study conducted in southern Ethiopia in which EPI data reliability level was assessed along with other health system indicators, which revealed that consistency of immunization data varies within records and reports (4). Data inaccuracies have been reported by other studies (4,21) which were conducted to assess health information system implementation; and there were variations between source documents and periodic reports. Another study also revealed that missing of relevant data elements during recording, delays in reporting, and inconsistency in EPI data are common challenges in health management information system (25). A study in Ethiopia also found that capacitating health extension workers, supporting them, and responding to the challenges they face, and digitizing health information systems could improve health system performances (23) as manual data documentation is prone to poor data management practices, and using electronic data handling, could improve timeliness, completeness, and accuracy of health care data (26, 27). A study from Uganda reported that technical challenges with limited technology support affects health management

information systems (23) and the level of accurate health information system performance is also challenged by technical, behavioral, and organizational factors (22). One study revealed improving data management practices from data collection to reporting enhances the program performance (10). A study conducted in Botswana (24) which shows limited monitoring and evaluation systems, poor standard practices of data handling, limited understandings of indicator definitions, and limited electronic health data management systems could affect healthcare data. Based on the findings, improving factors related to good EPI data generation, handling and use and giving attention to optimization methods of good EPI data management practices would bring better achievement. Shifting the current manual system into electronic data management systems would give a better and accurate health facility data that can be used to inform policies and decision making.

Conclusion

Over-reporting of immunization data elements while under recorded were observed in primary health care unit. Behavioral, organizational, technical factors, hard to reach areas, unavailability of EPI data recording and reporting formats, lack of trained health professionals, decreased motivation, and manual documentation of EPI data are commonly shared factors influencing EPI data generation, handling, and utilization. The findings of this study are an indication of much work which is necessary for improving the data management practices in primary health settings to accomplish quality immunization data generation, handling, and use.

Recommendations

Attention needs to be given to organizational, behavioral, and technical components to understand the quality of EPI data generation, handling, and use. Availing EPI recording and reporting tools in primary health care units is essential. Advancing manual data managing practices using electronic community health information systems could improve EPI data quality and inform good planning and decision making at lower health care systems. All administrative and service delivery health units need to take the role and responsibility in this regard. Governmental officials, and other stakeholders should give attention to training, supervision, and close follow up that could bring a paramount contribution in quality EPI data generation, handling, and use. Providing capacity building for the health workers who are working on immunization data recording and reporting could improve generation, handling and use of quality healthcare data at primary healthcare unit's level.

Abbreviations

CI: Confidence interval; DHIS: District Health Information System; EPI: Expanded Program on Immunization; EPI HC: Health Center; HMIS: Health Management Information System; HEW: Health Extension Workers; HP: Health Post; IRB: Institutional Review Board; SPSS: Statistical Package for the Social Sciences; SD: Standard deviation; VF: Verification factor

Declarations

Ethics approval and consent to participate

Ethical clearance was obtained from research Ethics committee of from Institutional Review Board (IRB) of University of Gondar. Supportive letters were obtained from Amhara regional Health Bureau, from central Gondar Zone health department, Wogera woreda Health Office, and from health centers under woreda health office.

Availability of data and materials

All relevant materials and data supporting the findings of this study will be availed with request.

Competing interests

The authors declare that they have no competing interests.

Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current Journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

Acknowledgments

This study was supported by the Alliance for Health Policy and Systems Research (Alliance). The Alliance is able to conduct its work thanks to the commitment and support from a variety of funders. These include UNICEF and Gavi, the Vaccine Alliance contributing designated funding and support for this project, along with the Alliance's long-term core contributors from national governments and international institutions. For the full list of Alliance donors, please visit: <https://ahpsr.who.int/about-us/funders>. We are also grateful to data collectors, supervisors, study participants and all stakeholders who were involved in this study.

References

1. WHO. Improving Data Quality: A Guide for Developing Countries. WHO; 2003
2. Guide to the Health Facility Data Quality Report Card. World Health Organization, 2013
3. Johnson K, Grant M, Khan S, Moore Z, Armstrong A, Sa Z. FieldworkRelated Factors and Data Quality in the Demographic and Health Surveys Program. DHS Analytical Studies No. 2009; 19.
4. Endriyas M, Alano A, Mekonnen E, Ayele S, Kelaye T, Shiferaw M, Misganaw T, Samuel T, Hailemariam T, Hailu S. Understanding performance data: health management information system data accuracy in Southern Nations Nationalities and People's Region, Ethiopia. BMC health services research. 2019 Dec;19(1):175.
5. Wakabi W. Extension workers drive Ethiopia's primary health care. The Lancet. 2008;372(9642):880.
6. Health FMO. Rural Community Health Information System Implementation Manual. Lancet. 2019;Vol. 372.

7. Harrison K, Rahimi N, Danivaro-Holliday MC. Factors limiting data quality in the expanded programme on immunization in low and middle-income countries: A scoping review. *Vaccine*. 2020 May 20.
8. World Health Organization. Assessment Report of The Global Vaccine Action Plan 2014. Available from: http://www.who.int/immunization/global_vaccine_action_plan/SAGE_DoV_GVAP_Assessment_report_2014_English.pdf
9. World Health Organization. Assessment Report of The Global Vaccine Action Plan 2014. Available from: http://www.who.int/immunization/global_vaccine_action_plan/SAGE_DoV_GVAP_Assessment_report_2014_English.pdf.
10. Abajebel S, Jira C, Beyene W. Utilization of health information system at district level in Jimma zone Oromia regional state, South West Ethiopia. *Ethiopian journal of health sciences*. 2011.
11. Adamki M, Asamoah Dominic, Riverson K. Assessment of Data Quality on Expanded Programme on Immunization in Ghana: The Case of new Juaben Municipality. *J Heal Med Informat*. 2015; 6.
12. Garrib A, Stoops N, McKenzie A, Dlamini L, Govender T, Rohde J. et al. An evaluation of the District Health Information System in rural South Africa. *S Afr Med J*. 2008; 98: 549-552.
13. Jandee K, Kaewkungwal J, Khamsiriwatchara A, Lawpoolsri S, Wongwit W, Wansatid P. Effectiveness of Using Mobile Phone Image Capture for Collecting Secondary Data: A Case Study on Immunization History Data Among Children in Remote Areas of Thailand. *JMIR Mhealth Uhealth*. 2015; 3: e75.
14. Qazi MS, Ali M. Pakistan's health management information system: health managers' perspectives. *J Pak Med Assoc*. 2009; 59: 10-14.
15. Nicol E, Bradshaw D, Phillips T, Dudley L. Human factors affecting the quality of routinely collected data in South Africa. *Stud. Health Technol. Stud Health Technol Inform*. 2013; 192: 788-792.
16. Kiberu VM, Matovu JK, Makumbi F, Kyoziira C, Mukooyo E, Wanyenze RK. Strengthening district-based health reporting through the district health management information software system: the Ugandan experience. *BMC Med Inform Decis Mak*. 2014; 14: 40.
17. Nsubuga F, Luzze H, Ampeire I, Kasasa S, Toliva OB, et al. (2018) Factors that affect immunization data quality in Kabarole District, Uganda. *PLOS ONE* 13(9): e0203747. <https://doi.org/10.1371/journal.pone.0203747>
18. WHO, Global Report on child healthcare services 2016
19. Manfred Ehling, Körner T. Handbook on Data Quality Assessment Methods and Tools. Wiesbaden: EUROPEAN COMMISSION; 2007
20. Federal Ministry of Health [Ethiopian]. Information Revolution Roadmap. Federal Ministry of Health [Ethiopian]; 2016.
21. Hiwot Belay, Tariq Azim, Kassahun H. Assessment of Health Management Information System (HMIS) Performance in SNNPR, Ethiopia. SNNP Regional Health Bureau and Measure evaluation, 2013.
22. Anwer Aqil, Dairiku Hozumi, Theo Lippeveld. Tools for Data Demand and Use in the Health Sector: Performance of Routine Information Systems Management (PRISM) Tools. MEASURE Evaluation; 2011.
23. Vincent Micheal Kiberu, Joseph KB Matovu, Fredrick Makumbi, Carol Kyoziira, Eddie Mukooyo, Wanyenze RK. Strengthening district-based health reporting through the district health management information software system: the Ugandan experience. *BMC Medical Informatics and Decision Making*. 2014;14(40).
24. Jenny H Ledikwe, Jessica Grignon, Refeletswe Lebelonyane, Steven Ludick, Ellah Matshediso, Baraedi W Sento, et al. Improving the quality of health information: a qualitative assessment of data management and reporting systems in Botswana. *Health Research Policy and Systems*. 2014;12(7).
25. Johnson K, Grant M, Khan S, Moore Z, Armstrong A, Sa Z. Fieldwork Related Factors and Data Quality in the Demographic and Health Surveys Program. DHS Analytical Studies No. 2009; 19.
26. Shrestha S, Shrestha M, Wagle RR, Bhandari G. Predictors of incompletion of immunization among children residing in the slums of Kathmandu valley, Nepal: a case-control study. *BMC Public Health*. 2016;16(1):970.
27. Quality and Use of Immunization and Surveillance Data, SAGE Working Group 2 April 2019)
28. Fedral Ministry of Health, Ethiopia National Expanded Programme on Immunization. 2015: Addis Ababa).
29. Mphatswe W, Mate K, Bennett B, Ngidi H, Reddy J, Barker P, et al. Improving public health information: a data quality intervention in KwaZulu-Natal, South Africa. *Bull World Health Organ*. 2012;90:176-82.
30. Mutale W, Chintu N, Amoroso C, Awoonor-Williams K, Phillips J, Baynes C, et al. Improving health information systems for decision making across five sub-Saharan African countries: implementation strategies from the African health initiative. *BMC Health Serv Res*. 2013;13(Suppl 2):S9.
31. AbouZahr C, Boerma T. Health information systems: the foundations of public health. *Bull*

