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Evaluation of the sentinel surveillance system for influenza-like illness and severe acute respiratory infection in Ethiopia during the COVID-19 pandemic, 2021–2023

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Abstract

Background The World Health Organization (WHO) recommends periodic evaluation of influenza surveillance systems. Such information would enable countries to assess the performance of their surveillance systems, identify shortfalls for improvement, and provide evidence of data reliability for policymaking and public health interventions. However, such data is lacking after the integration of other respiratory viruses into the existing influenza sentinel surveillance system in Ethiopia.

Methods We evaluated a total of 20 influenza-like illness (ILI)/ severe acute respiratory infection (SARI) sentinel sites using CDC guidelines that focused on the performance of the system from January 2021 to December 2023. The performance of the system was evaluated using ten surveillance attributes: (i) data quality and completeness for key variables, (ii) timeliness, (iii) representativeness, (iv) simplicity, (v) acceptability, (vi) utility, (vii) flexibility, (viii) stability, (ix) Sustainability, and (x) sensitivity. A structured evaluation tool consisting of 57 indicators was adopted with modifications from standard surveillance system evaluation guidelines and similar studies conducted in other African countries. Data were collected through record review (including CRFs, case enrollment logs, weekly reports, laboratory registrations, guidelines, bulletins, and publications) and interviews of key personnel across the surveillance system. Each indicator was scored out of 100% using the weighted average. The overall mean score of the attribute was scored from 1 to 3 and categorized as follows: < 60% weak performance; 60–79% moderate performance; ≥80% good performance.

Results About 18,724 cases were enrolled in ILI/SARI sentinel sites between January 2021 and December 2023 in the country. Among the total enrolled cases, Influenza, SARS-CoV-2, and RSV were detected in 1,648, 937, and 1,164 patients respectively. The overall mean score of the system during the study period was 2.5 (moderate to good

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performance). The evaluation showed that data quality and completeness, timeliness, simplicity, and stability were scored moderate to good performance while acceptability and sustainability measured weak performance. From the total indicators, 37(65%) of them scored good performance, however only 3(5%) of them scored weak performance.

Conclusions The overall performance of ILI/SARI sentinel surveillance was assessed as moderate to good. Data quality, completeness, timeliness, simplicity, and stability were rated as moderate to good. However, the acceptability and sustainability of the surveillance system require further attention to enhance the overall effectiveness of ILI/SARI sentinel surveillance in the country.

Keywords ILI/SARI sentinel, Evaluation, Surveillance, Ethiopia

Background

Acute respiratory infections (ARIs) are a major worldwide health problem associated with high morbidity and mortality [1–3]. They account for 4.25 million deaths annually and are a leading cause of death globally. Infection from many pathogens can result in ARIs, among which viruses are the major causes and they range from asymptomatic infections to severe respiratory diseases in both adults and children [4]. Moreover, the burden of ARIs on healthcare systems has been increasingly recognized due to hospitalization mainly occurring in high-risk groups due to severe acute respiratory infections (SARI) and outpatient visits attributed to Influenza-like illness (ILI) [5].

The COVID-19 pandemic has highlighted the significance of respiratory surveillance systems at the population level, a recognition further supported by WHO. Given the similarities in the clinical presentation of the viruses and the need to monitor disease trends, they released guidelines for the countries to integrate other respiratory viruses into the existing Global Influenza Surveillance and Response System (GISRS) [6, 7].

Ethiopia has more than a decade of experience in ILI/SARI sentinel surveillance. The ILI/SARI sentinel surveillance system was first established in Ethiopia in 2008 in Addis Ababa City and subsequently expanded to different geographical locations in the country. Overall, 21 ILI/SARI surveillance sites, four sub-national respiratory virus testing laboratories, 12 regional state health bureaus, and a National Influenza Center (NIC) have been involved in this surveillance system in Ethiopia.

The country integrated other respiratory surveillance into the system at the end of 2020 following WHO recommendations [7]. The integration brought an opportunity to establish four subnational respiratory viral testing laboratories in addition to a national influenza center in the country that was supported by the US-CDC, WHO, and Ohio State University Global One Health Initiative. This allows immediate COVID-19 testing for individuals meeting SARI/ILI criteria, enhancing surveillance and response efforts [8]. Indeed, it played a critical role during the pandemic by detecting surges in severe respiratory cases, which is used to minimize the impact of the disease by planning appropriate control and intervention measures and allocating health resources.

Despite ILI/SARI sentinel surveillance providing key insights during the COVID-19 pandemic in the country, the system is not evaluated after the integration of other respiratory viruses including SARS CoV-2 into the existing country's ILI/SARI sentinel surveillance system. In addition, WHO recommends periodic evaluation of the system to maintain data accuracy for informed decision-making [9]. Therefore, this study was designed to assess the performance of the ILI/SARI sentinel surveillance system in the country. Such data is very critical to monitor these viruses especially those with pandemic potential and to make timely public health decision-making by improving the effectiveness and efficiency of the system.

Methods

Overview of ILI/SARI sentinel surveillance system

From a total of 21 ILI/SARI sentinel sites in the country, 20 of them (4 health centers implementing ILI surveillance and 16 hospitals implementing SARI surveillance) were evaluated (Fig. 1). One site (Jinka General Hospital) was excluded because the site joined the surveillance system lately and there was insufficient time to evaluate its performance. At each sentinel site, there were dedicated trained staff (i.e., doctors, nurses, or laboratory technicians) who would identify and enroll patients who meet ILI and SARI case definitions, complete the individual case investigation forms (CIFs), collect respiratory tract samples, and facilitate shipment of CIFs and the samples to the testing laboratories.

The surveillance case definition for SARI is an acute respiratory infection with a history of fever or measured fever of ≥38 °C and cough, onset within the last 10 days, and requiring hospitalization. Whereas, ILI is defined as an acute respiratory infection with measured fever ≥38 °C, cough, and onset within the last 10 days. According to the case definition, ILI cases are screened from outpatient departments (OPD), while SARI cases are identified among admitted patients. Separate sites were established for ILI and SARI. Consequently, ILI sites are health centers, and SARI sites are hospitals. Case enrollment follows the WHO and National protocols, taking into account the national

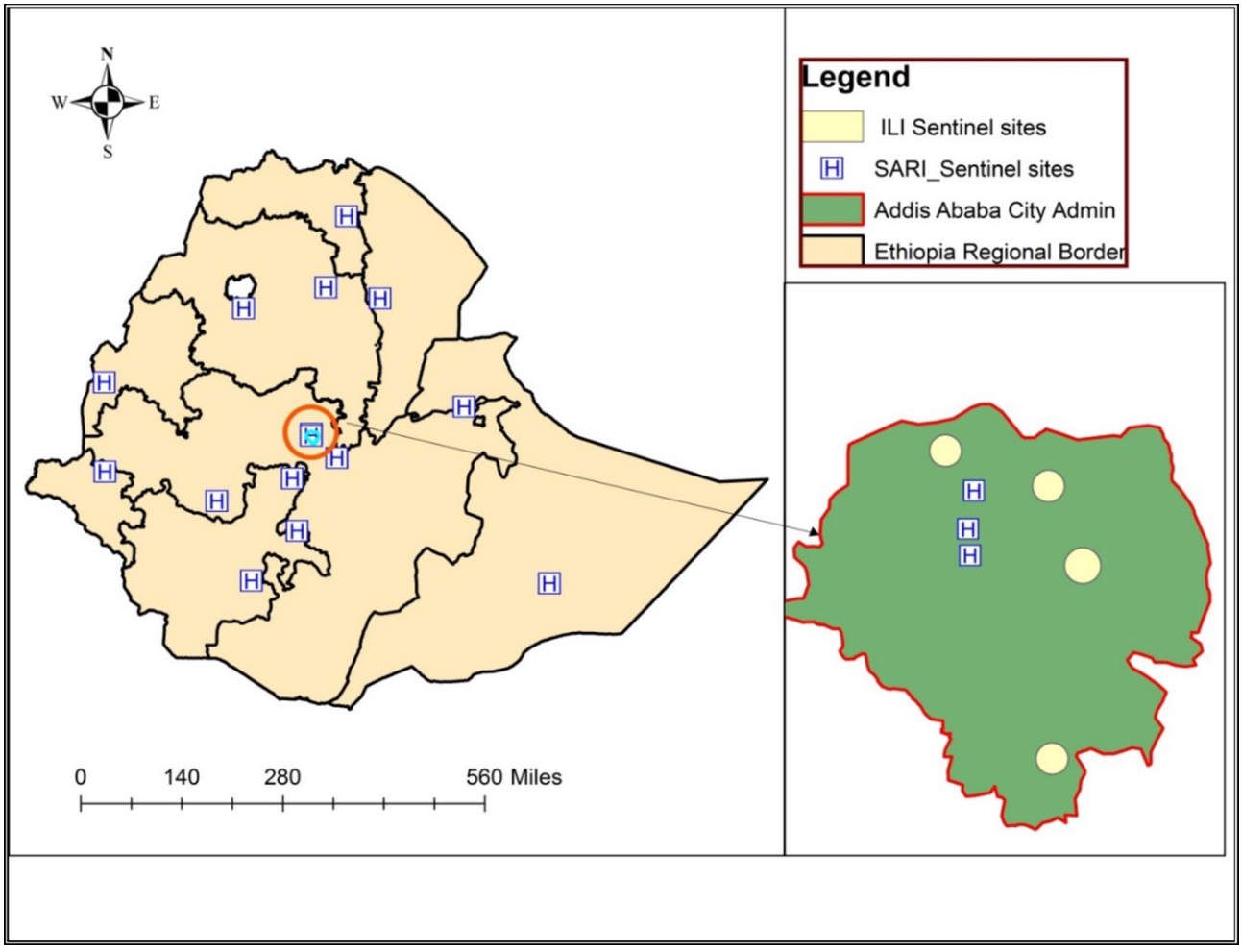

Fig. 1 Distribution ILI/SARI sentinel sites in Ethiopia from 2021–2023 (source of the map shape file: https://data.humdata.org/dataset/cod-ab-eth)

testing capacity. According to these protocols, all SARI cases are enrolled, while the first five ILI cases per day are selected for enrollment (Ethiopian Public Health Institute (EPHI): Sentinel surveillance protocol for influenza, COVID-19 and other respiratory viruses, unpublished).

Data management and reporting

The reporting format includes case definitions, sociodemographic information, clinical symptoms, pre-existing medical conditions, vaccine and antiviral history, travel and exposure history, and patient outcome status. Weekly aggregate data have also been reported in addition to CRFs from both ILI and SARI sentinel sites. The data reporting channel from sentinel sites to influenza testing laboratories includes both District Health Information System-2 (DHIS2) and paper-based. Both virological and epidemiological aggregate data have been reported to WHO via RespiMart (FluNet/FluID) weekly (Ethiopian Public Health Institute (EPHI): Sentinel surveillance protocol for influenza, COVID-19 and other respiratory viruses, unpublished).

Sample collection and laboratory procedures

Nasopharyngeal or throat swabs were collected from patients eligible for enrollment who met the ILI/SARI case definition. Each sentinel site has a protocol to collect throat or nasopharyngeal swab specimens as part of the sentinel surveillance system and each focal person at the sentinel site was well-trained on specimen collection, management, and transportation. The sentinel site focal persons obtain verbal consent from each patient before the collection of samples. Specimens were placed in the viral transport media (VTM) stored at 4–8 °C and transported to the NIC/sub-national influenza laboratories within 72 h of collection for testing (Ethiopian Public Health Institute (EPHI): Sentinel surveillance protocol for influenza, COVID-19 and other respiratory viruses, unpublished) [10].

Specimens were tested for influenza A and B viruses using the U.S. CDC real-time reverse-transcription polymerase chain reaction (RT-PCR) protocol for the characterization of influenza viruses [10]. Influenza A-positive samples were further subtyped. In addition, testing for

SARS-CoV-2 and RSV was also conducted following a previously developed procedure [11].

Influenza sentinel surveillance system evaluation techniques

The evaluation of the ILI/SARI sentinel surveillance system was based on CDC guidelines [12] and focused on the performance of the system from January 2021 to December 2023. Accordingly, the performance of the system was evaluated using ten surveillance attributes: (i) data quality and completeness for key variables, (ii) timeliness, (iii) representativeness, (iv) simplicity, (v) acceptability, (vi) utility, (vii) flexibility, (viii) stability, (ix) Sustainability, and (x) sensitivity. For each attribute, specific indicators were developed and described quantitatively and/or qualitatively.

A structured evaluation tool consisting of 57 indicators was adopted with modifications from CDC standard surveillance system evaluation guidelines and similar studies conducted in other African countries [12–16] by national surveillance experts. The indicators used to assess various attributes of the surveillance system include Data Quality and Completeness (13 indicators), Timeliness (3 indicators), Representativeness (3 indicators), Simplicity (11 indicators), Acceptability (4 indicators), Utility (5 indicators), Flexibility (4 indicators), Stability (11 indicators), Sustainability (2 indicators), and Sensitivity (1 indicator).

Data collectors were trained for the tool before they deployed it for evaluation. Data were collected through record review (including CRFs, case enrollment logs, weekly reports, laboratory registrations, guidelines, bulletins, and publications) and key personnel interviews across the system including sentinel sites, regional public health institute/health bureau, influenza testing laboratories, and national surveillance unit. Moreover, a cross-check of 10% of the surveillance data from 2021 to 2023 was performed by reviewing patient charts in the facilities and at all levels of the surveillance system. The data collection was conducted using Kobo Toolbox and exported to MS Excel.

Data processing and analysis

Descriptive statistics such as frequencies and proportions were calculated to characterize each variable. Each indicator was scored out of 100% using the weighted average. The weighted average was calculated by multiplying each response's frequency by its scale value, summing the results, and dividing by the product of the maximum scale value and the total number of responses. Then, to get the overall mean score of a single attribute, the sum of a weighted average of all indicators was divided by the number of indicators. Finally, the weighted average of each indicator and the overall mean score of the attribute was scored from 1 to 3 and categorized as follows: < 60% weak performance; 60–79% moderate performance; ≥80% good performance according to previously conducted studies in other Africa countries [13, 14]. For the qualitative indicators assessing representativeness, scores were assigned based on expert consensus. After extensive discussions, all experts agreed on the ratings for each indicator used to measure representativeness. An overall score for the surveillance system was obtained by averaging the ten mean attribute scores was calculated as previously described [13–16]. Data collected from the surveillance system were also compared with WHO minimum data collection standards for ILI and SARI surveillance [6]. The data analysis was carried out using MS Excel.

Ethical approval

The evaluation was conducted based on the periodic evaluation of the surveillance system as described in the national ILI/SARI sentinel surveillance guideline and it is the mandate of the Ethiopian Public Health Institute (EPHI) (Ethiopian Public Health Institute (EPHI): Sentinel surveillance protocol for influenza, COVID-19 and other respiratory viruses, unpublished). Thus, ethical clearance from the EPHI's Ethical Review Board (IRB) was not mandatory. Any patient-level or individual-level identifier was anonymized.

Results

About 18,724 cases were enrolled in ILI/SARI sentinel sites between January 2021 and December 2023 in the country. Among the total enrolled cases, Influenza, SARS-CoV-2, and RSV were detected in 1,648, 937, and 1,164 patients respectively. The overall mean score of the system during the study period was 2.5 (moderate to good performance). The evaluation showed data quality and completeness, timeliness, simplicity, and stability were scored moderate to good performance while acceptability and sustainability measured weak performance (Table 1).

The performance of the ILI/SARI surveillance system was evaluated using ten surveillance attributes and 57 indicators. From the total indicators, 37(65%) of them scored good performance, however only 3(5%) of them scored weak performance (Fig. 2).

Data quality and completeness

The mean score of data quality and completeness was 2.6, which is a moderate to good performance. The lowest performance score (47.7%) was found for the number of enrolled patients with ILI against the set target (35 patients per week per site). The scores for the proportion of report completeness from sentinel sites to NIC by week and the proportion of sampled ILI/SARI cases with available laboratory results at the surveillance sites were

Table 1 Mean indicators' scores (range 1–3) for each attribute used for the evaluation of the ILI/SARI Sentinel surveillance system in Ethiopia, 2021–2023

Attributes	Number of evaluated indicators	Mean score	Ranges of scores across indicators (min, max)	Performance
Data quality and completeness	13	2.6	(1, 3)	Moderate to good
Timelines	3	2.3	(2, 3)	Moderate to good
Representativeness	3	3	All scored 3	Good
Simplicity	11	2.4	(2, 3)	Moderate to good
Acceptability	4	1.8	(1, 2)	Weak
Utility	5	3	All scored 3	Good
Flexibility	4	3	All scored 3	Good
Stability	11	2.8	(2, 3)	Moderate to good
Sustainability	2	1.5	(1, 2)	Weak
Sensitivity	1	3	Scored 3	Good
Overall	57	2.5	(1, 3)	Moderate to good

min minimum, *max* maximum

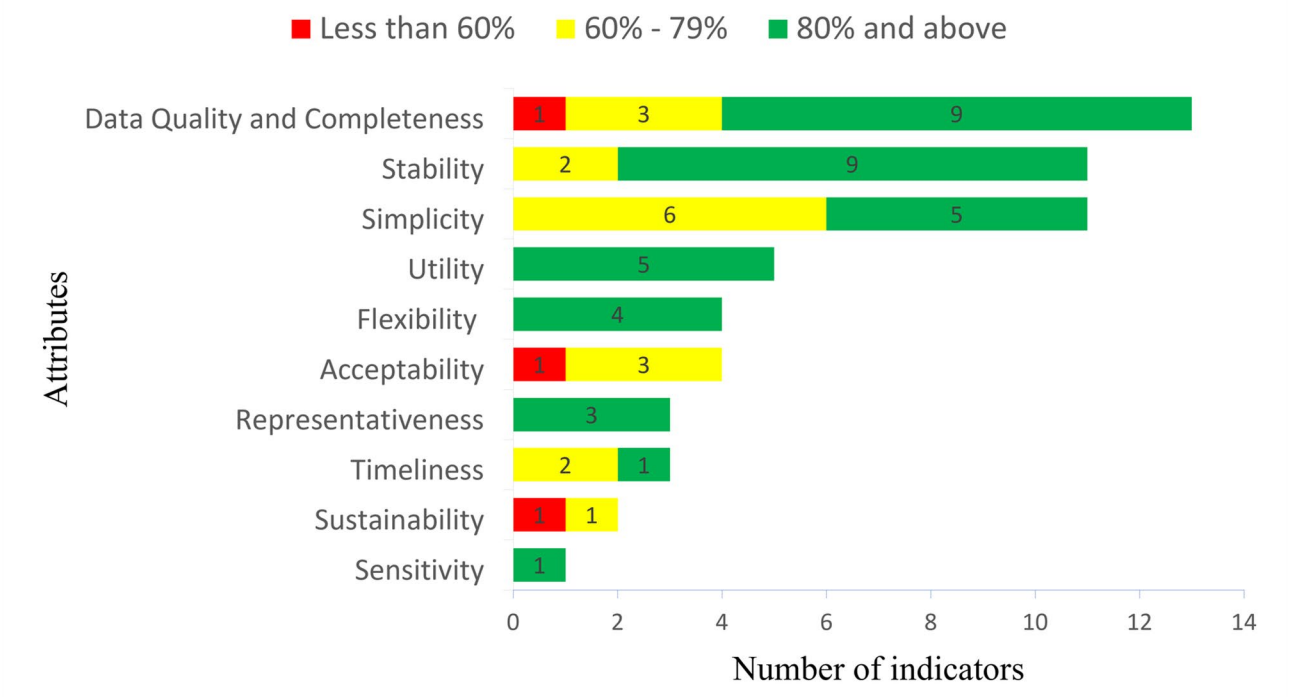

Fig. 2 Summary of the scores for the number of indicators used for each attribute in the ILI/SARI sentinel surveillance system evaluation in Ethiopia, 2021–2023

74%, and 60%, respectively, indicating moderate performance (Table 2).

Timelines

Overall, the performance score for timeliness of the ILI/SARI sentinel surveillance system was 2.3 showing a moderate to good performance. The proportion of data and samples sent to the testing laboratories within 7 days increased from 61.4% in 2021 to 86.4% in 2023. The proportion of weekly laboratory result feedback given timely was consistently at 100% across all three years. However, the proportion of influenza data reported timely to WHO was initially low at 36.5%, but substantial improvements were seen in subsequent years: reaching 86.5% in 2022 and further increasing to 88.5% in 2023 (Table 2).

Representatives

The implementation of the ILI/SARI sentinel surveillance system in 12 out of 14 regional states in the country is a positive development (Fig. 1). These sentinel sites were carefully selected to represent various socioeconomic groups, population densities, and geographic regions.

Table 2 List of indicators and scores for data quality and completeness, timelines and representativeness used for the evaluation of the ILI/SARI Sentinel surveillance system in Ethiopia, 2021–2023

System attribute and indicators	Calculation	Data sources	Indicator value (%)			Weighted Average	Score
			2021	2022	2023		
Data quality and completeness	13 indicators					87.5	2.6
Proportion of enrolled patients with ILI against set target (35 patients per week per site)	Number of enrolled patients with ILI / Estimated target.	Case-based and aggregate database	27.7	50.5	64.8	47.7	1
Proportion of enrolled patients with SARI against set target (all eligible SARI cases)	Number of enrolled patients with SARI / All patients with SARI	Case-based and aggregate database	94.5	98.3	87.8	93.6	3
Proportion of forms without at least one inconsistent or missing value for key variables	Number of forms without at least one incorrect or missing value / Total number of forms	case investigation form	96.6	96.2	91.3	94.7	3
Proportion of sampled ILI/SARI cases with available laboratory results	Number of ILI/SARI cases with available laboratory results / Number of sampled ILI/SARI cases	Laboratory log book and case-based database	-	-	-	60	2
Proportion of report completeness for sentinel sites by week	Number of weeks report made /Total number of weeks	Case-based database	54	82	85	74	2
Proportion of samples received with accompanying CRF at regional lab	Number of ILI/SARI samples received with accompanying CRF by regional influenza laboratory /Total number of samples received	Case-based database and case investigation form		100	99.9	100	3
Proportion of samples received with accompanying CRF at NIC	Number of ILI/SARI samples received with accompanying CRF by NIC/Total number of samples received	Case-based database	99.9	100	100	100	3
Proportion of quality samples received by region	Number of good quality samples received / Total number of samples received	Case-based database	-	100	99.9	100	3
Proportion of sample tested by regional labs	Total number of samples tested by regional labs/Total number of samples received	Case-based database	-	100	100	100	3
Proportion of samples fulfill acceptance criteria that sent to NIC	Number of samples that fulfill acceptance criteria sent to NIC / Total number of samples sent to NIC	Case-based database	99.9	100	99.9	99.9	3
Proportion of sample tested by NIC	Total number of samples tested by NIC/ Total number of samples received by NIC	Case-based database and FluNet reports	99.9	100	99.9	99.9	3
Weekly Virological data report completeness to WHO (FluNet)	Number of weeks virological data reported to WHO/ Total number of weeks	Case-based database and FluID reports	100	100	100	100	3
Weekly epidemiological data report completeness to WHO (FluID)	Number of weeks epidemiological data reported to WHO/ Total number of weeks	Case-based database and FluID reports	0	100	100	67.7	2

Table 2 (continued)

System attribute and indicators	Calculation	Data sources	Indicator value (%)			Weighted Average	Score
			2021	2022	2023		
Timelines	3 indicators		66	8.76	91.6	81.4	2.3
Proportion of data and samples sent from the sentinel site within 7 days from the time collection	Number of weeks that data and samples sent from the sentinel site within 7 days from the collection/Total number of weeks that data and samples sent from the sentinel site	Case-based, Aggregate database and case investigation form	61.4	73.7	86.4	73.8	2
Proportion of weekly laboratory result feedback given timely(within 7 days)	Number of weekly laboratory result feedback reported timely/ Total number of weeks	Laboratory log book and case-based database	100	100	100	100	3
Proportion of influenza data reported to WHO timely (7 days)	Number of weeks influenza data reported to WHO timely/ Total number of weeks	Flumart reports and WHO weekly reports	36.5	86.5	88.5	70.5	2
Representativeness	3 indicators						3
Geographical coverage of the sentinel sites by regions	Number of regions covered by SARI/ILI sentinel sites/Total number of regions	Geographic distribution of sentinel sites.				84.6	3
Inclusion of all age groups in the country	Age distribution of SARI/ILI cases (minimum, median and maximum)	Case based and aggregate database	Min = 3d; Max = 100y; Med = 14 y				3
Inclusion of both sex	Sex distribution of SARI/ILI cases	Case based and aggregate database	M = 49.2; F = 50.8				3

The age and sex distribution of the detected cases aligns with the overall population distribution in the country with a score of three in all indicators.

Acceptability

The overall proportion of surveillance staff satisfaction was weak with a mean score of 1.8. The proportion of surveillance staff that was satisfied with the ILI/SARI sentinel surveillance system, with weekly laboratory, and supervision feedback were 75%, 76% & 68.5% respectively. However, half of the surveillance team expressed low satisfaction with the adequacy of time dedicated weekly to the surveillance tasks with a mean score of 1(Table 3).

Utility/usefulness

The system was scored 3(good performance) across the five indicators of utility. It provides valuable insights into the burden and patterns of the influenza virus among patients with ILI or SARI. It also produces useful data through regular reports, which allows for estimating the burden of the illness and the weekly distribution of the cases. However, there is a need for improvement in digitalizing the system in all sites using DHIS2 because the lack of computers and skill gaps are becoming a bottleneck in some sites and regional states (Table 3).

Flexibility

The flexibility of the system was good in all of the analyzed indicators, indicating that it is very adaptable. The previously existing influenza surveillance system in the country was easily modified to accommodate additional viral diseases like SARS-CoV-2 and RSV, as well as indicators like vaccination to monitor other viral respiratory pathogens (Table 3).

Sustainability

The overall average score of the two indicators used to evaluate the sustainably of the sentinel surveillance system have scored weak performance. The weighted average of the sites at least financially supported once a year during the study period was 66.7% while the availability and implementation of a sustainability plan was measured 25% (Table 3).

Sensitivity

The system detected a total of 9 outbreaks out of 10 flu-like outbreaks reported and investigated. Thus, the sensitivity of the system in detecting outbreaks was good (90%) (Table 3).

Stability

The total average score of stability of the ILI/SARI surveillance system was moderate to good performance with a mean score of 2.8. Among the eleven indicators used for the attribute, the proportion of surveillance system interruption in the last year scored 78.8% and the proportion of regional Influenza laboratories with at least two staff members trained for the testing procedures was 60%. The rest of the indicators for this attribute showed a good performance and all the facilities have at least two staff members trained for ILI/SARI surveillance protocols and procedures (Table 4).

Simplicity

The simplicity of the system was scored 2.4 indicating moderate to good performance. Of the nine indicators used to evaluate the simplicity of surveillance activity at sentinel sites more than half of them scored a moderate performance. Of 40 sentinel site surveillance staff interviewed, the majority 24(60%) perceived that the time to enroll a SARI/ILI case from the identification to the sample packaging takes 30–60 min. Most of the surveillance staff perceived it was easy to deliver the majority of ILI/SARI surveillance activities at their facilities (Table 5).

Discussion

In this evaluation, we have assessed the ILI and SARI sentinel surveillance system in Ethiopia from 2021 to 2023 to identify areas for improvement and provide evidence for program implementation. The overall performance of the surveillance system was moderate to good, with a mean score of 2.5.

The finding of this surveillance system revealed that there was moderate to good performance concerning data quality and completeness. Good data quality and completeness are important to make evidence-based decisions for timely interventions. Likewise, good performance was reported from the Democratic Republic of Congo [13], moderate to good performance was reported from Zambia [14], and moderate performance was reported from Ghana [14]. In enrolling cases, there was good performance for SARI cases (93.6%), but the enrolment of ILI cases was below 50%. The low ILI case enrollment in this surveillance might be due to the short health facility stay of the cases at the outpatient department and the workload of focal persons to enroll them.

In this surveillance, there was good performance in completing the key variables in the CRF including epidemiological and virological data. Periodic training, supervision from the national and sub-national Public health emergency management (PHEM) officers, review meetings, and the availability of recruited staff by OSU-GOHi for this surveillance played an important role *in* this performance. However, there is a gap in weekly reporting from the surveillance sites to the NIC and availing the laboratory results at the surveillance sites. Timely reporting and availing laboratory results are critical

Table 3 List of indicators and scores for sustainability, sensitivity, utility and flexibility used for the evaluation of the ILI/SARI Sentinel surveillance system in Ethiopia, 2021–2023

System attribute and indicators	Calculation	Data source	Weighted Average	Score
Acceptability				
Proportion of surveillance staff that is satisfied with the weekly SARI/ILI laboratory feedback	Number of surveillance staff within each reported category/ Number of surveillance staff interviewed	Questionnaire survey among surveillance staff	76.0%	2
Proportion of surveillance staff that is satisfied with supervision and feedback	Number of surveillance staff within each reported category / Number of surveillance staff interviewed	Questionnaire survey among surveillance staff	68.5%	2
Proportion of surveillance staff that is satisfied with SARI/ILI surveillance system?	Number of surveillance staff within each reported category / Number of surveillance staff interviewed.	Questionnaire survey among surveillance staff	75.0%	2
Proportion surveillance staff that was satisfied on adequacy of time allocated to influenza surveillance activities per week	Number of hours allocated to influenza surveillance activities per week / Number of working hour per week (average hours- 20 h and expected 40 h)	Questionnaire survey among surveillance staff	50.0%	1
Sustainability				
SARI/ILI sites at least financially supported once in a year	SARI/ILI sites at least financially supported once in a year / total sites	Report of budget transfers, Questionnaire survey among surveillance staff	66.70%	2
Availability and implementation of a Sustainability plan	Sites with Availability and implementation of a Sustainability plan/ total no of sites	EPRP, Annual plans	25%	1
Sensitivity				
The proportion of the number of outbreaks identified by the system	the overall number of outbreaks detected by the system divided by the total no of outbreaks that was occurred during the study period	report of outbreaks detected	90%	3
Utility				
Proportion of weeks with data reported to WHO FluNet	Number of weeks with data reported to WHO FluNet/ Total number of expected weeks	Case-based database and FluNet reports	100%	3
Number of contributions to influenza Regional/ Global studies	Number of publications on Regional/Global studies with influenza data from Ethiopia	Publications on Regional/Global studies with Ethiopia SARI/ILI data, samples sent to WHO CC	100%	3
Mean annual number of samples shared with WHO Collaborating Centers (WHO CC)	Number of samples/isolates shared with WHO CC / Number of years with samples shipped.	reports samples sent to WHO CC	100%	3
Proportion of surveillance staff that receive the following reports: (i) Virological surveillance report, (ii) Syndromic surveillance report, (iii) Influenza bulletin	Number of surveillance staff that receive reports / Number of surveillance staff	Questionnaire survey among surveillance staff at sentinel sites	100%	3
Ability to assess important influenza epidemiological features/public health outcomes		Publication on burden of influenza associated ILI and SARI, report of outbreaks detected	80%	3
Flexibility				
Case definition can be easily customized to include other respiratory pathogens and new variants or other indicators	Yes	Questionnaire survey among surveillance staff at sentinel sites		3
How many times it has customized in the last three years	2 times	Questionnaire survey among surveillance staff		3
Number of other viral respiratory pathogens surveyed with the influenza surveillance system	2			3
Proportion of samples tested for pathogens other than influenza	Number of sample tested other than influenza / Number of sample tested for influenza	Laboratory log book and case-based database	Covid19 = 97.7% RSV = 62.5%	3

Table 4 List of indicators and scores for stability used for the evaluation of the ILI/SARI Sentinel surveillance system in Ethiopia, 2021–2023

Stability	11 indicators	Data source	*N*	0 times(4)	1 times(3)	2–3 times (2)	>=4 times (1)	Weighted Average	Score
Proportion of surveillance system interruption in the last one year	Number of weeks surveillance system interruption in the last one year/total number weeks	Questionnaire for surveillance staff at sentinel sites	20	12	2	3	3	78.8%	2
Proportion of SARI/ILI dedicated staff changed in the course of one year	Number of SARI/ILI dedicated staff changed in the course of one year/ Total number of SARI/ILI dedicated staffs	Questionnaire for surveillance staff at sentinel sites	20	12	4	4	1	86.3%	3
Proportion of weeks lack of SARI/ILI data collection forms occurred	Number of weeks lack of SARI/ILI data collection forms occurred/ total number of weeks	Questionnaire for surveillance staff at sentinel sites	20	17	1	1	1	92.5%	3
Proportion of weeks lack of SARI/ILI of sample collection materials occurred	Number of weeks lack of SARI/ILI of sample collection materials occurred / total number of weeks	Questionnaire for surveillance staff at sentinel sites	20	13	1	5	1	82.5%	3
Proportion of weeks sample transportation was delayed	Number of weeks sample transportation was delayed/ total number of weeks	Questionnaire for surveillance staff at sentinel sites	20	13	3	2	2	83.8%	3
Functionality of SARI/ILI sample storage refrigerator	Number of surveillance sites within each reported category / Number of surveillance sites	Questionnaire for surveillance staff at sentinel sites	20	N(4)	S(3)	O(2)	R(1)		
				18	1	1	0	96.3%	3
Power interruption	Number of surveillance sites within each reported category / Number of surveillance sites	Questionnaire for surveillance staff at sentinel sites	20	13	6	1	0	90.0%	3
Proportion of sentinel sites with at least two member of staff trained on sentinel surveillance procedures	Number of sentinel sites with at least two trained member of staff / Number of surveillance sites	Questionnaire for surveillance staff at sentinel sites	20	All have 2 focal				100.0%	3
					NA (1)	ANU(2)	AU(3)		
Availability and utilization of latest version guideline	Number of surveillance sites within each reported category / Total number of surveillance sites	Questionnaire for surveillance staff at sentinel sites	20		2	2	16	90.0%	3
Proportion of weeks lack of SARI/ILI of testing kits/materials occurred	Number of weeks lack of SARI/ILI of testing kits/materials occurred / total number of weeks	Questionnaire for surveillance staff at sentinel sites	5					95.0%	3
Proportion of regional Influenza labs with at least two member of staff trained on Influenza testing procedures	Number of Influenza regional lab with at least two trained member of staff / Total number of regional Influenza labs	Questionnaire for surveillance staff at sentinel sites	5					60.0%	2

Abbreviations: *N* never, *S* seldom, *O* often, *R* regularly, *NA* Not available, *ANU* available but not used, *AU* available and used

Table 5 List of indicators and scores for simplicity used for the evaluation of the ILI/SARI Sentinel surveillance system in Ethiopia, 2021–2023

Simplicity	Indicators (11)	*N*	Data source	VD(1)	D(2)	E(3)	VE (4)	Weighted Average	Score
Perception of surveillance staff on identification of cases	Number of surveillance staff within each reported category / Number of surveillance staff interviewed	40	Questionnaire survey among surveillance staff at sentinel sites	2	4	14	20	82.5%	3
Perception of surveillance staff on obtaining consent	Number of surveillance staff within each reported category / Number of surveillance staff interviewed	40	Questionnaire survey among surveillance staff at sentinel sites	0	12	24	4	70.0%	2
Perception of surveillance staff on filling the CRF	Number of surveillance staff within each reported category / Number of surveillance staff interviewed	40	Questionnaire survey among surveillance staff at sentinel sites	0	2	28	10	80.0%	3
Perception of surveillance staff on using DHIS2 data system	Number of surveillance staff within each reported category / Number of surveillance staff interviewed	40	Questionnaire survey among surveillance staff at sentinel sites	10	8	18	4	60.0%	2
Perception of surveillance staff on sample collection	Number of surveillance staff within each reported category / Number of surveillance staff interviewed	40	Questionnaire survey among surveillance staff at sentinel sites	0	4	28	8	77.5%	2
Perception of surveillance staff on packaging and storage of sample	Number of surveillance staff within each reported category / Number of surveillance staff interviewed	40	Questionnaire survey among surveillance staff at sentinel sites	0	0	26	14	83.8%	3
Perception of surveillance staff on completing the screening/enrollment logbook	Number of surveillance staff within each reported category / Number of surveillance staff interviewed	40	Questionnaire survey among surveillance staff at sentinel sites	2	4	24	10	76.3%	2
Perception of surveillance staff on sending weekly aggregated data	Number of surveillance staff within each reported category / Number of surveillance staff interviewed	40	Questionnaire survey among surveillance staff at sentinel sites	0	6	28	8	80.0%	2
Perception of laboratory staff on completing laboratory register	Number of lab staff within each reported category / Number of surveillance staff interviewed	10	Questionnaire survey among laboratory staff at regional and national labs	0	2	4	4	80.0%	3
Perception of laboratory staff in implement Influenza testing procedures	Number of lab staff within each reported category / Number of surveillance staff interviewed	10	Questionnaire survey among laboratory staff at regional and national labs	0	0	10	0	75.0%	2
Time to enroll a SARI/ILI case from the identification to the sample packaging	Number of surveillance staff within each reported category (< 30 min, 30–60 min) / Number of surveillance staff interviewed	40	Questionnaire survey among surveillance staff at sentinel sites	< 30 min (2) 30–60 min (1)	16 24			80.0%	3

Abbreviations: *VD* Very Difficult, *D* Difficult, *E* Easy, *VE* Very Easy

to take site-specific interventions. This system evaluation revealed that respiratory virus testing laboratories tested all the received specimens within the epidemiological week. The expansion of four respiratory virus testing laboratories at the sub-national level was pivotal in decreasing the testing load at NIC to test all the received specimens within the given period.

Timelines in the current study was measured using three indicators; proportion of data and samples sent from sites to testing laboratories, weekly laboratory result feedback, and influenza data reported to WHO within 7 days. The finding revealed that the overall timeliness performance was moderate to good with a mean score of 2.3, and there was an improvement for all three indicators from 2021 to 2023. This might be due to the expansions of influenza testing laboratories, and the deployment of surveillance officers by OSU-GOHi at the majority of surveillance sentinel sites.

The geographic representativeness of the current ILI/SARI sentinel surveillance in Ethiopia was good which covered 12 out of 14 regional states and there is a plan to expand the sites in the remaining two regions. This resulted in Ethiopia having a higher percentage of regions implementing the ILI/SARI surveillance system compared to other African countries such as Zambia, South Africa, DRC, Ghana, and Tanzania [13–15, 17, 18].

In this surveillance evaluation, the simplicity attribute, which is crucial for an effective surveillance operation, revealed a moderate to good overall performance. Most surveillance staff at sentinel sites found patient identification, filling CRF, and sample collection were simple, attributing this to the necessary training and materials at hand. However, some challenges were noted, such as obtaining consent from patients for tests conducted solely for surveillance purposes. This needs to be improved through conducting regular health education to the patients on the importance of ILI/SARI surveillance. All of the sentinel surveillance site staff perceived that the time to enroll a SARI/ILI case from identification to sample packaging takes below 60 min which revealed the simplicity of the surveillance system. The indicator evaluating the perception of laboratory staff on completing the laboratory register showed a good performance level, which is also revealed by the good data quality and completeness in this surveillance. Whereas, the indicator related to the perception of laboratory staff on influenza testing procedures showed a moderate performance. Overall, the findings suggest that while the surveillance system is generally perceived as simple to use, there are areas for improvement.

The overall acceptability of the ILI/SARI surveillance system revealed a weak performance score with a mean score of 1.8, which needs to be strengthened. Three of the four indicators scored moderate, however, one indicator that assessed surveillance staff satisfaction with the adequacy of time allocated to surveillance activities per week scored weak performance. Low acceptability of the ILI/SARI sentinel surveillance may be improved through creating regional ownership, strengthening PHEM activities at the health facility level including creating advocacy, and setting accountability and ownership at the facility level.

In line with its objectives, the current ILI/SARI sentinel surveillance demonstrated its utility through its ability to monitor the temporal patterns of circulating influenza viruses, monitor the circulating influenza types/ subtypes, assess the proportional contribution of ILI/SARI illness attributable to influenza virus infection, and estimating the burden of influenza-associated illness. Through this surveillance system, the NIC continuously reported data to the WHO FluNet, generated samples that were shared with the WHO collaborating centers, and contributed to regional studies through publication [11, 19–21]. Furthermore, all stakeholders received useful data from the surveillance system through regular reports, such as weekly, monthly, and annual influenza surveillance bulletins. Overall, the usefulness of the ILI/SARI surveillance system in the country is undisputable, but it needs improvement to digitalize the system using DHIS2.

Flexibility in a surveillance system refers to the system's ability to modify its case definition and adapt to changing circumstances, including new variants and other respiratory pathogens. The overall performance of the surveillance system was good with a mean score of 3. The revised SARI/ILI sentinel surveillance protocol in Ethiopia includes SARS-CoV-2 and RSV (Ethiopian Public Health Institute (EPHI): Sentinel surveillance protocol for influenza, COVID-19 and other respiratory viruses, unpublished), demonstrating the system's flexibility. However, it's important to improve the surveillance system to include more respiratory pathogens. In Madagascar, 14 respiratory pathogens are under the surveillance [16].

The assessment of the stability and sustainability of the national surveillance system is crucial for understanding its efficacy in monitoring and responding to respiratory disease outbreaks. In this assessment, the overall mean score of the system's sustainability was weak to moderate performance, with a mean score of 1.5. A similar finding was identified in the sentinel surveillance system evaluation in Zambia, where weak performance was observed [13]. This result suggests potential vulnerabilities in the system's ability to maintain consistent surveillance activities and respond adequately to emerging threats over time. However, amidst the overall weaknesses, the indicator assessing the financial support provided to the sites at least once a year showed moderate performance, suggesting that there is some level of financial backing for

surveillance activities. This is essential for sustaining the operation of surveillance sites and maintaining data collection efforts.

Conversely, the availability and implementation of a sustainability plan exhibited a significantly lower score that underscores a notable gap in the system's preparedness for long-term sustainability and resilience against evolving public health emergencies. A sustainability plan is essential for outlining strategies and resources needed to ensure the continued operation and improvement of the surveillance system.

With regard to stability, with eleven indicators assessed, the majority of the system's components demonstrate good performance, contributing to an average stability score of 2.8. This finding is similar to the influenza system evaluations from the Democratic Republic of the Congo [13], and Zambia [13]. While the overall performance was moderate to good, however, there have been some disruptions and interruptions in the functioning of the surveillance system suggesting a need for attention to ensure the continuity and effectiveness of surveillance activities. Addressing the factors contributing to interruptions, such as technical issues, staffing shortages, or resource constraints, is essential for maintaining the system's reliability and responsiveness to public health threats. In addition, the Influenza testing procedures training gaps observed in the assessment highlight a gap in the preparedness and capacity of subnational laboratories for conducting Influenza testing. Adequate training of laboratory staff is crucial for accurate and timely diagnosis of infectious diseases, including Influenza, and for maintaining the quality and reliability of surveillance data. On the positive side, the remaining indicators demonstrate good performance, with notable strengths in areas such as the functionality of the ILI/SARI sample storage refrigerator and staff training at sentinel sites. These areas of good performance indicate efficient operational practices, effective training programs, and strong infrastructure supporting surveillance activities [22].

The sensitivity of the ILI/SARI surveillance system had a good performance with an overall mean score of 3. This surveillance system was able to detect 9 out of 10 flu-like outbreaks in the country demonstrating the system's good sensitivity. Surveillance systems are important in alerting the concerned bodies to detect outbreaks as early as possible. In support of this, the Tanzania Influenza surveillance system was able to detect all the outbreaks that occurred in the country [18]. The presence of at least one sentinel site at each included regional states, increased number of trained manpower, ownership and commitment of subnational health bureaus, and better communication mechanisms in responding to any respiratory activities among the sentinel site, regions, and national institutes contributed a lot.

Conclusions

The overall ILI/SARI sentinel surveillance performance was moderate to good. According to this study, data quality and completeness, timeliness, simplicity, and stability were scored moderate to good performance; however, acceptability and sustainability and acceptability of the surveillance need to be underscored to improve the ILI/SARI sentinel surveillance in the country.

Abbreviations

ARI	Acute respiratory infections
CRF	Case reporting form
EPHI	Ethiopian Public Health Institute
ILI	Influenza-like illness
NIC	National Influenza Center
PHEM	Public health emergency management
RSV	Respiratory syncytial virus
SARI	Severe acute respiratory infection
VTM	Viral transport media
WHO	World Health Organization

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Authors' contributions

Conceptualization: TB, AT, AG, GT, WS, AA, AW, LG, AA, LC, MG, FK, AH, FI, EG, MK, ZM, DM, MH, MA, MWData curation and Formal analysis: TB, AT, AG, GT, WS, AA, AW, LG, AA, LC, MG, FK, AH, FI, EG, MK, Methodology: TB, AT, AG, GT, WS, AA, AW, LG, AA, LC, MG, FK, AH, FI, EG, MKResources: MK, ZM, DM, MH, MA, MWWriting – original draft: TB, AT, AG, GT, WS, AA, AW, LG, AA, LC, MG, FK, AH, FI, EG, MK, ZM, DM, MH, MA, MWWriting – review & editing: TB, AT, AG, GT, WS, AA, AW, LG, AA, LC, MG, FK, AH, FI, EG, MK, ZM, DM, MH, MA, MW.

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Data availability

The data will be available upon request.

Declarations

Ethics approval and consent to participate

Informed consent to participate in this study was obtained from all of the participants. According to the Ethiopian SARI/ILI sentinel surveillance protocol, periodic evaluation of the SARI/ILI sentinel surveillance system is one of the routine activities and falls under the mandate of the EPH. The System evaluation was deemed non-research by EPHI and the U.S. CDC. Ethics approval was deemed not necessary and waived by the institutional review board (IRB) of EPHI.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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