

## **Assessing Effective Vaccine Management in West Shewa Zone, Ethiopia**

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## **Acknowledgements**

We would like to thank the International Institute for Primary Health Care-Ethiopia for its support of this study. We are also grateful to the study participants for sharing their time and expertise and Ambo University's administrative staff for their cooperation at every stage of the project.

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## **Acronyms**

WHO  
EVM  
DTP  
EPI  
MCH  
EEFO  
MDVP  
ISM

World Health Organization  
Effective vaccine management  
Diphtheria-tetanus-pertussis vaccine  
Expanded Program on Immunization  
Maternal and Child Health  
Earliest-expiry first-out  
Multi-dose vial policy  
Information systems and management

## Abstract

**Background:** Immunization is a high-impact, low-cost intervention, responsible for averting an estimated two to three million deaths each year. Despite improvements in immunization rates, children in Ethiopia do not have equal access to these services. A well-functioning immunization supply chain is crucial to reducing disparities and improving vaccination coverage.

**Objective:** To assess the performance of the immunization supply chain in West Shewa zone, Ethiopia.

**Methods:** We conducted a mixed-method, cross-sectional study using assessment tools designed by the World Health Organization (WHO). A total of 43 stores (1 sub-national store, 14 district stores and 28 health facilities) were randomly selected and assessed on eight performance criteria for effective vaccine management (EVM). Data were analyzed using a software developed by the WHO and EVM scores were consolidated for each store level and the entire zone. Each criterion was compared against the WHO's recommended minimum score of 80% to evaluate the strength of the immunization supply chain. Forty-three key informants were purposively chosen to participate in the qualitative portion of the study. Interviews were transcribed, translated into English and analyzed using OpenCode software.

**Results:** The average scores for the zone across all performance criteria ranged from 43% to 75% - below the WHO-recommended minimum standard. The West Shewa sub-national store achieved the minimum score for temperature monitoring (90%) and building, cold chain equipment and transport (82%), and the district stores achieved the minimum score for storage capacity (80%). Health facilities scored poorly in five out of the eight measures of performance compared with higher-level stores. Overall, the zonal average was highest for storage capacity (75%), temperature monitoring (74%) and vaccine management (73%), and lowest for stock management (55%), information systems and management (48%) and maintenance of building, cold chain equipment and transport (43%).

**Conclusion:** Our study found that the immunization supply chain in West Shewa zone was poor. In-service training, computerized vaccine stock management systems and the installation of solar refrigerators may improve the immunization supply chain in this region.

## Background

Immunization is a high-impact, low-cost intervention (1), responsible for averting an estimated two to three million deaths each year (2). According to joint estimates by the World Health Organization (WHO) and the United Nations Children's Fund, national immunization coverage improved in Ethiopia between 2008 and 2018 (3). Yet, disparities remain between and within regions: the 2016 Demographic Health Survey showed that only 20.1% of children 12-23 months had received DTP3 in Afar region, compared with 81.4% in Tigray (4). A key factor in reducing disparities and improving vaccination coverage is a strong immunization supply chain.

In 2010, the WHO and partner organizations launched the Effective Vaccine Management (EVM) initiative (5) "... to help countries evaluate the performance of their immunization supply chains..." (p.3). The agencies developed an EVM assessment tool that can be applied to each level of the supply chain - from the national to service level - to support this initiative. Each indicator or criterion is benchmarked against best-practice standards and a score of at least 80% suggests effective vaccine management.

A global analysis of national EVM assessments conducted between 2010 and 2013 revealed that between only 8% and 43% of low- and lower-middle income countries achieved the minimum score on any criterion (5). The median score in the African region was below 80% on every criterion of performance at each level of the supply chain (6).

In 2013, Ethiopia conducted a national EVM assessment and achieved a consolidated score of 67% (7). The assessment identified storage capacity, transportation and "qualitative aspect[s] of the infrastructure" as strengths of the supply chain (7, p.34). It highlighted storage temperature, stock management, distribution and vaccine management as weaknesses (7). A national cold chain equipment inventory showed that a shortage of skilled maintenance workers, the lack of spare parts and an overreliance on electricity and kerosene affected the country's ability to maintain a functional cold chain system (7).

A few studies have also assessed immunization supply chains at regional and local levels in Ethiopia. One study conducted in the central region found that professional qualification and years of service were significantly associated with knowledge about cold chain management (8). Other studies have shown that supportive supervision and the provision of written feedback to subordinates contributed to a strong immunization supply chain (9-12). Although the number of studies evaluating immunization supply chains in Ethiopia is growing, gaps remain in this area of research. The purpose of this study is to assess the performance of the immunization supply chain in West Shewa zone, Ethiopia.

## Methods

### Study design and setting

We conducted a mixed-method, cross-sectional study in West Shewa zone from March to June 2018. West Shewa zone is located in the Oromia region of Ethiopia, 114 kilometers west of the capital city, Addis Ababa. It has 22 districts (woredas) and a population of 2,607,827 people. According to the zonal health office, the area's primary care facilities consisted of 6 hospitals, 91 health centers and 514 health posts in 2017.

### Population

The source population for the quantitative data were stores at each level of the immunization supply chain in West Shewa zone, including the sub-national store, district stores and health facilities. District stores, which are the lowest delivery level, receive vaccines and supplies from the sub-national store (which itself receive items from the national store in Addis Ababa) and distribute them to health facilities. The source population for the qualitative data were the heads of health facilities and district health offices, and coordinators of the Expanded Program on Immunization (EPI) who were stationed in health facilities, district health offices and the West Shewa zone health office.

### Sampling

The sample size and a representative sample of immunization stores at each level of the supply chain were determined using a WHO online tool developed for EVM assessments. Based on a confidence interval of 90% and a margin of error of 10%, the suggested sample size was 43: 1 sub-national store, 14 district stores and 28 health facilities.

Systematic random sampling was used to obtain a representative sample of district stores using the WHO EVM site selection guide. Two health facilities were randomly selected from each of the 14 districts where the district stores were located. Since the number of health facilities was greater than the number of district stores, two health centers were randomly selected from each of the seven districts with the largest populations and one health center and one health post were randomly selected from the remaining districts (Table 1).

A total of 43 in-depth interviews were also conducted. The key informants were 28 health workers from health facilities working for the Expanded Program on Immunization, 14 district health office representatives and one representative from the sub-national store.



Table I. List of sample stores by supply chain level

Sub-national Store: n=1	District Stores n=14	Health Facilities: Health Centers (HC=21) & Health Posts (HP=7) n=28
West Shewa zone vaccine store	Jeldu-Wereda	Gojo HC and Shukute HC
	Ambo Wereda	Meti HC and Altufa HC
	Dano-Wereda	Seyo HC and Bake Sirba HC
	Bako Tibe-Wereda	Bako HC and Shoboka HC
	Ada Berga-Wereda	Enchini HC and Reji HC
	Dendi-Wereda	Ginchi HC and Asgori HC
	Abuna Gindeberet-Wereda	Bake Kalate HC & Gute Andode HC
	Toke Kutayu-Wereda	Guder HC and Wakjira HP
	Cheliya-Wereda	Gedo HC and Racho HP
	Tikur Enchini-Wereda	Enchini HC and Waldo HP
	Ejere-Wereda	Ejere HC and Kusaye HP
	Jibat-Wereda	Shenen HC and Bilomalima HP
	Liban Jawi	Babichi HC and Kombolcha HP
Ejersa Lafoo	Olnkomi HC and Gaba Dilbata HP	

### Data collection

The data collection tool was adapted from the WHO EVM assessment questionnaire (version 2.1). The tool assesses an immunization supply chain system across nine areas or criteria (listed below) against established performance standards. For an assessment at the sub-national level, a review of eight EVM criteria (all except vaccine arrival) is recommended.

1. Vaccine arrival: pre-shipment and arrival procedures ensure that every shipment from the vaccine manufacturer reaches the receiving store in satisfactory condition and with the correct paperwork.
2. Temperature control: vaccines and diluents are stored within the WHO recommended temperature range in the cold chain system.
3. Storage capacity: cold storage, dry storage and transport capacity are sufficient to accommodate all vaccines and supplies needed for the program.
4. Building, cold chain equipment and transport: the state of storage buildings, cold chain equipment and vehicles for distributing vaccines and supplies is acceptable.
5. Maintenance: maintenance systems for storage buildings, cold chain equipment and vehicles are satisfactory.
6. Stock management: effective stock management systems and procedures are in place.
7. Distribution: vaccines are distributed between each level in the supply chain in an effective manner.

8. Vaccine management: appropriate vaccine management policies are adopted and implemented at all levels of the immunization supply chain.
9. Information systems and management: relevant information systems and supportive management functions are satisfactory.

To ensure quality data collection, we recruited supervisors and enumerators with relevant education and work experience. Quantitative data were collected by nurses and health officers and qualitative data were collected by professionals with graduate degrees in public health. All data collectors had experience with data collection and familiarity with immunization programs.

Data collectors and supervisors received intensive training on the objectives of the study, the data collection instruments and procedures for data collection. A pre-test was conducted on purposively selected health facilities (that were not included in the study) to gauge the data collectors' and supervisors' understanding of data collection tools and procedures.

During data collection, on-site supportive supervision and field editing were conducted, and questionnaires and interviews were checked for completeness and consistency at the end of each day. The investigators closely monitored data collection and provided feedback to data collectors and supervisors.

### **Data analysis**

Quantitative data were entered into and analyzed using the EVM Analysis and Recommendation Tool (version 1.0) – a software developed by the WHO for EVM data analysis. Consolidated scores for EVM were calculated for each store level and the entire zone. Each criterion was compared against the WHO's recommended minimum score of 80% to evaluate the strength of the immunization supply chain. In-depth interviews were transcribed verbatim and translated into English. OpenCode software was used to analyze the knowledge and experience of personnel at vaccine stores.

### **Ethical clearance**

The investigators obtained ethical clearance from the Institutional Review Board at Ambo University's College of Medicine and Health Sciences. Following its approval of the study, the College of Medicine and Health Sciences' Office of Research sent a letter explaining the purpose of the study and requesting the cooperation of local health offices and vaccine stores. Informed consent was sought from key informants and personal identifiers were excluded from forms to maintain confidentiality.

## Results

Table 2 shows that the zonal average was below the minimum standard for every criterion of effective vaccine management. The zone scored between 79% and 60% on three criteria - storage capacity (75%), temperature monitoring (74%) and vaccine management (73%) - and scored below 60% on all the others. At the store level, only the sub-national store and the district stores achieved the recommended minimum score for any criterion: the sub-national store received 90% for temperature monitoring and 82% for building, cold chain equipment and transport; and the district stores scored 80% for storage capacity. Health facilities scored poorly on almost all criteria compared to higher-level stores.

Table 2. Summary of EVM scores for West Shewa zone and three levels of supply chain

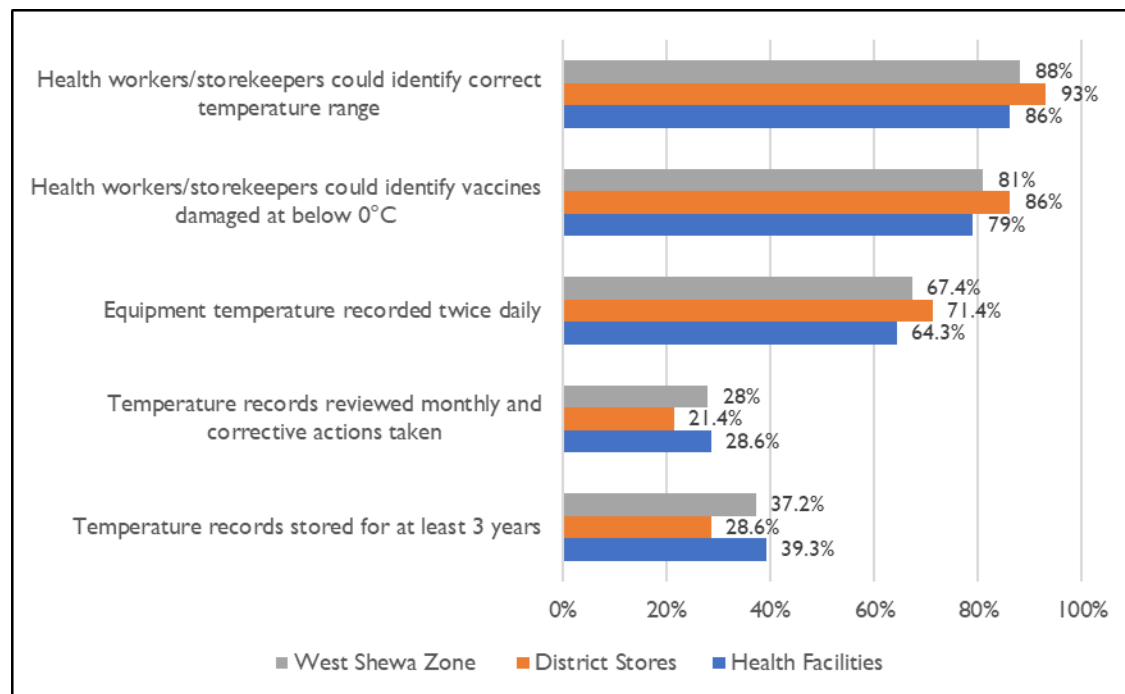
EVM Criterion	West Shewa Zone Average	Sub-national Store (n=1)	District Stores (n=14)	Health Facilities (n=28)
Temperature monitoring	74%	90%	74%	73%
Storage capacity	75%	61%	80%	74%
Building, cold chain equipment & transport	62%	82%	68%	59%
Maintenance	43%	56%	50%	40%
Stock management	55%	78%	69%	47%
Distribution	65%	59%	62%	66%
Vaccine management	73%	77%	74%	72%
Information systems & management	48%	58%	54%	45%

### Temperature monitoring

The West Shewa average score for temperature monitoring was 74% (Table 2). Only the sub-national store met the minimum standard for temperature monitoring (90%). In aggregate, district stores and health facilities performed comparably (Table 2). However, a higher proportion of health facilities met the recommended standard (n=10, 35.7%) compared with district stores (n=4, 28.6%).

Figure 1 shows that knowledge regarding temperature monitoring was more wide-spread than practice. More than 80% of health workers and storekeepers knew the correct temperature range for vaccine storage and 86% of storekeepers at district stores knew the temperature point at which vaccines could be damaged. In contrast, a fewer percentage of workers at district stores and health facilities (71.4% and 64.3%, respectively) reported recording the temperature of their vaccine refrigerators twice a day as recommended. Less than a third of all health facilities and district stores reviewed their temperature records on a monthly basis and 37% of all stores in the zone kept temperature records for at least three years (Figure 1).

Figure 1. Performance scores for selected temperature monitoring indicators



Key informants revealed that temperature monitoring was inconsistent at health facilities and district stores, largely due to power interruptions. Key informants stated that the standard procedure was to monitor storage temperature twice a day using a refrigerator or “fridge” tag (a built-in temperature monitoring device). However, this was not often possible. According to an EPI Coordinator at a health center:

*“Vaccines should be kept between 2°C and 8°C. We record the storage temperature twice a day on a chart, during morning and afternoon hours. Previously, we used a fridge tag but now we use the thermometer because the fridge tag expired.”*

An EPI Coordinator from a different district added:

*“There is a refrigerator that works using a solar system. However, since the solar refrigerator is not adequate, another type of refrigerator is used. When we lose electric power, it is difficult to monitor vaccine temperature.”*

### Storage capacity

The consolidated score for West Shewa zone was 75% for storage capacity (Table 2). The district stores achieved the highest score (80%), while the sub-national store scored the lowest (61%) (Table 2). Out of 14 district stores, 10 (71.4%) had a storage capacity score greater than 80% and 8 (28.6%) health facilities had a performance score above 80%.

The results also showed that 92.9% of district stores and 82.1% of health facilities had adequate cold storage capacities at 2°C to 8°C. However, there was a shortage of vaccine storage space at the required temperature range at the sub-national store and at health posts.

Key informants had mixed views of storage capacity in their respective stores. Many of the respondents stated that there was adequate cold storage capacity in their stores while others suggested that cold and dry storage capacities were insufficient. The EPI coordinator from a district health office, for example, stated that they had no problem in this regard: *“We have sufficient storage capacity to store vaccines needed for one month.”* The EPI focal person from another district health office asserted that they did not face any challenges when it came to storage capacity: *“Cold storage, dry storage and transport capacities are sufficient to accommodate all vaccines and supplies.”* The EPI coordinator of another district health office, on the other hand, expressed their difficulty with cold storage: *“We are facing a major challenge when it comes to cold storage. The recommended standards are not strictly followed in this regard.”* Despite the sub-standard showing of the zone in the quantitative assessment, the zonal EPI coordinator suggested that cold and dry storage capacities were sufficient in the zone.

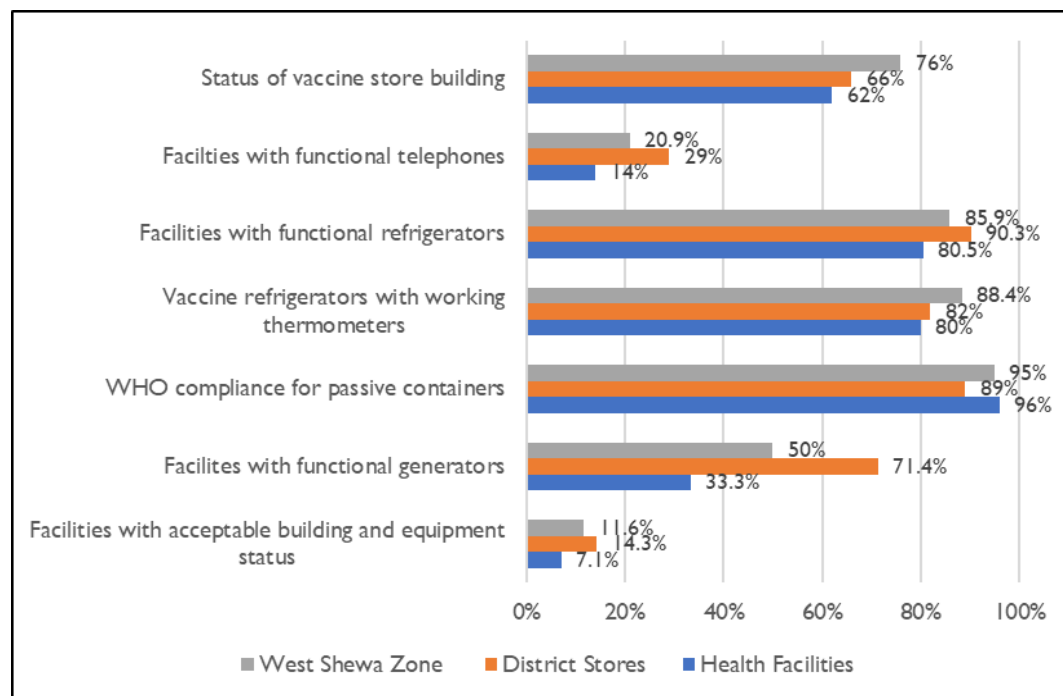
### **Building, cold chain equipment and transport**

The consolidated performance score for building, cold chain equipment and transport was 62% (Table 2). The sub-national store performed best (82%), followed by district stores (68%) and health facilities (59%) (Table 2). Among the lower-level stores, only 2 (14.3%) district stores and 2 (7.1%) health facilities reached the minimum performance score of 80%.

Figure 2 shows performance scores for selected building and cold chain equipment indicators. The zone scored fairly well on building status. We found functional telecommunication systems in 29% of district stores and 14% of health facilities. The status of cold chain equipment was strong across all levels. Among the 43 vaccine stores visited, 38 (88.4%) had refrigerators/freezers. Out of a total of 78 refrigerators/freezers found, at least 80% were functional with working thermometers. The district stores and health facilities also scored very high on compliance with WHO standards for passive containers (cold boxes and vaccine carriers). The main sources of power for the refrigerators/freezers were electricity (n=51, 65.4%), kerosene (n=16, 20.5%) and solar (n=11, 14.1%). Ten (71.4%) district stores and only seven (33.3%) health centers had generators to supply electricity during power outages. Despite a strong showing on cold chain equipment status, the zone performed poorly when building and equipment status were combined.

Refrigerated trucks were used to transport vaccines directly to the sub-national store and to district stores. Cars were mainly used to deliver to lower-level stores.

Figure 2. Performance scores for selected building and cold chain equipment indicators



Key informants at district stores and health facilities noted that lack of consistent power was a common phenomenon and a major problem affecting vaccine management in West Shewa zone, where power outages lasted as long as a week. They reported using several different strategies to ensure that vaccines were stored properly in the face of chronic power loss.

**Solar power:** About four district health offices installed refrigerators that used solar power. Two of them relied on a non-governmental organization to install solar refrigerators because financial support from the government was minimal.

*“Menschen for Menschen, a non-governmental organization, has been assisting us by donating refrigerators. They have also financed the installation of a solar system which has been very useful because there is a shortage of electric power supply in our area.” (District EPI Coordinator)*

**Transfer to a building with power:**

*“Our major challenge is electricity. In case of a power blackout, there is no reserve generator. There are only two refrigerators. One of them uses solar power and, whenever we experience an extended blackout, we take our vaccines to the wereda [district] health office.” (Health Center, MCH Coordinator)*

*“The challenge that we repeatedly face is the lack of a consistent electric power supply. When there is no electricity, we take all vaccines to the health center where there is solar power.” (District EPI Coordinator)*

**Cold box:**

*“Regarding vaccine storage in our health office, there is a lack of consistent power supply. (...) To overcome this challenge, we use the cold box.” (District EPI Coordinator)*

**Power generator:**

*“What we have to our advantage is a generator that we use when there is no electric power. It has helped us to safely and effectively store vaccines whenever there is a power cut, which often happens in this area.” (District MCH Coordinator)*

The status and quality of the storage building was another factor that affected the effectiveness of vaccine management at local health centers. Following was one EPI Coordinator’s take on the status of their storage building and vehicles:

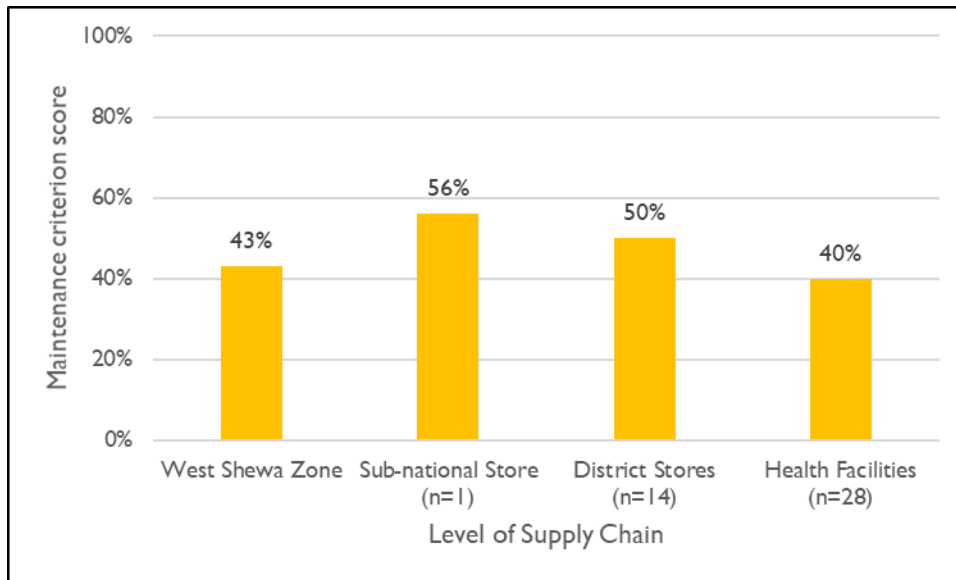
*“The storage building is not up to standard because it is exposed to light and wind. The cold chain equipment is acceptable. The fleet of vehicles is totally unacceptable. Health extension workers transport vaccines on foot because there are no vehicles available for that purpose. The problem is that this may expose the vaccines to heat”.*

On the other hand, some health centers had access to motorbikes to transport vaccines. An EPI focal person at a health center said: *“We use human power and motorbikes, which are not comfortable and do not keep vaccines potent.”*

**Maintenance**

The zone received the lowest score (43%) on maintenance of building, cold chain equipment and transport (Table 2). All store levels scored below 60%, with health facilities receiving the lowest score (Figure 3). Of the 78 refrigerators/freezers found, 11 (14.7%) were non-functional: 3 (9.7%) at district stores and 8 (19.5%) at health facilities. None of the vaccine stores had a written maintenance plan.

Figure 3. Summary performance scores for maintenance



Key informants cited the absence of trained maintenance staff, unresponsive higher-placed officials and a limited budget as the main reasons for poor maintenance. Many deemed maintenance services as unsatisfactory or unacceptable.

An MCH Coordinator for a district health office offered his assessment of a situation that has district stores relying on the zonal office for most of their maintenance needs. *“Overall, I think maintenance is not satisfactory. Maintenance services are provided by the zonal office. We can only do maintenance for cold storage facilities.”*

According to an MCH Director, reliance on the zonal office meant that support was often inconsistent or incomplete:

*“Refrigerators and vehicles are repaired if they are damaged. Maintenance is not regularly performed. The storage building has never been inspected. But whenever there is a need for maintenance, skilled personnel are called upon from the zone.”*

District stores were dependent on the zonal office for maintenance because of the shortage of skilled personnel on-site and limited training opportunities for new hires on equipment use. The EPI Coordinator of a district health office described this challenge as follows:

*“There is a skill gap regarding refrigerator use and maintenance of appliances because of the lack of training. This has resulted in wastage. Two refrigerators are now out of use as a result of the skill gap. Nobody has received training on the refrigerator tag, so we are using the manual one because we cannot read the tag. Staff turnover is high, and training should be offered regularly to new staff.”*

While district stores struggled with maintenance issues, the extent of the problem seemed considerably worse at health posts, where, at some sites, maintenance had never been



performed. The EPI Coordinator of a health post reported their struggle to secure maintenance services: *“Maintenance has never been done. I have reported several times the need to do maintenance on the refrigerator, but still no response.”*

The zonal health office confirmed that maintenance was provided for refrigerators upon request by the district stores, but maintenance was rarely performed on storage buildings. The EPI expert for the zonal health office described maintenance issues as follows: *“Maintenance for storage buildings is rare but there is a biomedical professional who can maintain refrigerators.”*

### Stock management

Stock management was one of the worst performing indicators of effective vaccine management in West Shewa zone (Table 2). The overall score for the zone was 55% (Figure 4). Health facilities received the lowest score, and a nine-point difference separated the sub-national and district stores (78% and 69%, respectively) (Figure 4). Only 4 (28.6%) district stores and 2 (7.1%) health facilities scored higher than 80%.

Figure 4. Summary performance scores for stock management

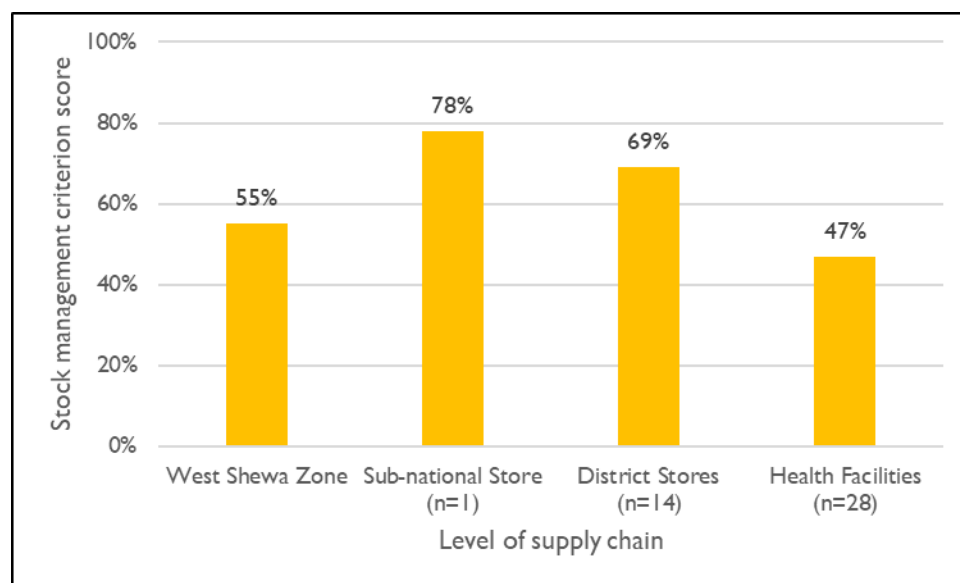


Table 3 shows performance scores for selected stock management indicators. Between 38% and 67% of all stores defined the maximum and minimum levels of stock they needed. None of the stores we visited used a computerized stock control system. All parameters of vaccines and diluents were not recorded at any level in the supply chain, and only the sub-national store met the minimum score for recording all the salient parameters for vaccines. Physical counts of vaccines and consumables rarely matched the counts on stock records, particularly at health facilities. Stores at all levels overwhelmingly used earliest-expiry first-out (EEFO) in selecting which vaccines to use or distribute first. In 64% of district stores and 57% of health facilities, the damaged or expired stock were properly recorded and disposed of in accordance with standing orders. Only 44% of stores in West Shewa zone had secured records.

Table 3. Performance scores for selected stock management indicators

Indicator	West Shewa Zone Average	Sub-national Store (n=1)	District Stores (n=14)	Health Facilities (n=28)
Maximum & minimum levels of stock defined	53%	67%	55%	38%
All salient vaccine parameters recorded	76%	87%	76%	64%
All salient diluent parameters recorded	63%	75%	61%	54%
Physical check of vaccines matched stock records	57%	75%	55%	42%
Physical check of consumables matched stock records	59%	75%	64%	38%
Followed EEFO	89%	100%	93%	82%
Damaged or expired stock properly recorded & disposed according to standing orders	65%	67%	64%	57%
Followed good practices for warehousing vaccines	79%	80%	80%	77%
Followed good practices for warehousing consumables	68%	75%	75%	54%
Records secured	44%	100%	57%	36%

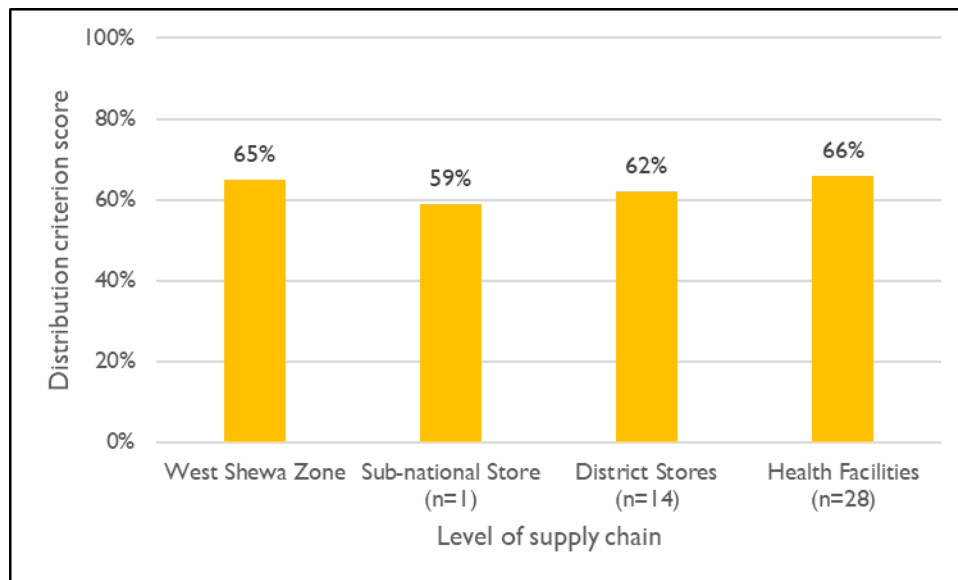
Key informants revealed that district stores followed comparable stock management practices, including vaccine evaluation, inventory and reporting. The following quote by an EPI coordinator at a district health office shed light on the most common stock management practices:

*“Vaccines received and issued are recorded by model, and the balance is maintained in a logbook. First-in first-out is basically the principle that we are following. We conduct a physical count of vaccines. A vaccine and its diluent batch number should be the same. If not, we don’t use it. Inventory is performed twice a year. Vaccine vial management is used to identify which vaccines to discard.”*

### Distribution

Overall, the zone received a score of 65% for distribution (Figure 5). Health facilities scored highest on this criterion (66%) and the sub-national store scored the lowest (59%) (Figure 5). On two indicators of effective distribution – compliance with the delivery schedule and proper conditioning of ice packs – the districts stores performed above the minimum recommended score (86% and 96%, respectively). At all levels, stores did not consistently use freeze indicators when transporting vaccines.

Figure 5. Summary performance scores for distribution



Key informants identified transportation as a major challenge in vaccine distribution. Their principle concern was the number of vehicles available (all key informants noted that there was only one vehicle per district) and the type of vehicles at their disposal. An MCH Coordinator at a district health office offered his assessment on the use of pick-up trucks, which were commonly used to transport vaccines to health posts:

*“Vaccines should be distributed as quickly as possible to prevent vaccine exposure to cold and heat (...). A pick-up truck is used to distribute vaccines to health centers using a cold box. This is not acceptable because the vehicles are not customized for this purpose and the safety of transporting and distributing [vaccines] using a pick-up is questionable.”*

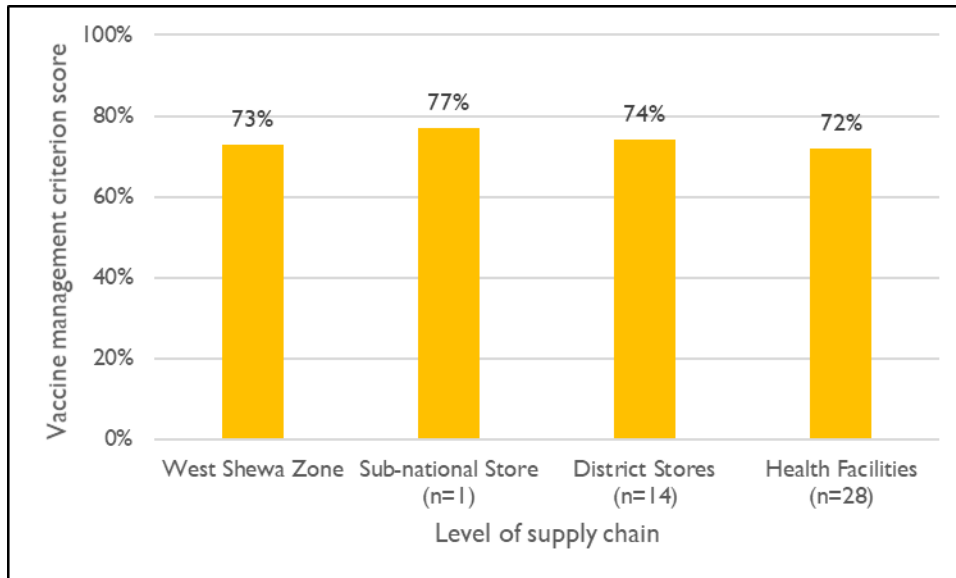
The MCH Coordinator of another district health office expressed his frustration over having only one car and relying on motorbikes to deliver to rural health posts:

*“In my view, vaccine distribution is not effective or efficient. There is only one car, which is not enough to distribute vaccines to all the health centers and health posts in the district. For remote health centers, we use motorbikes, even though they may not be appropriate to keep the vaccines potent. We try our best to keep the vaccine temperature right by using cold boxes.”*

### **Vaccine management**

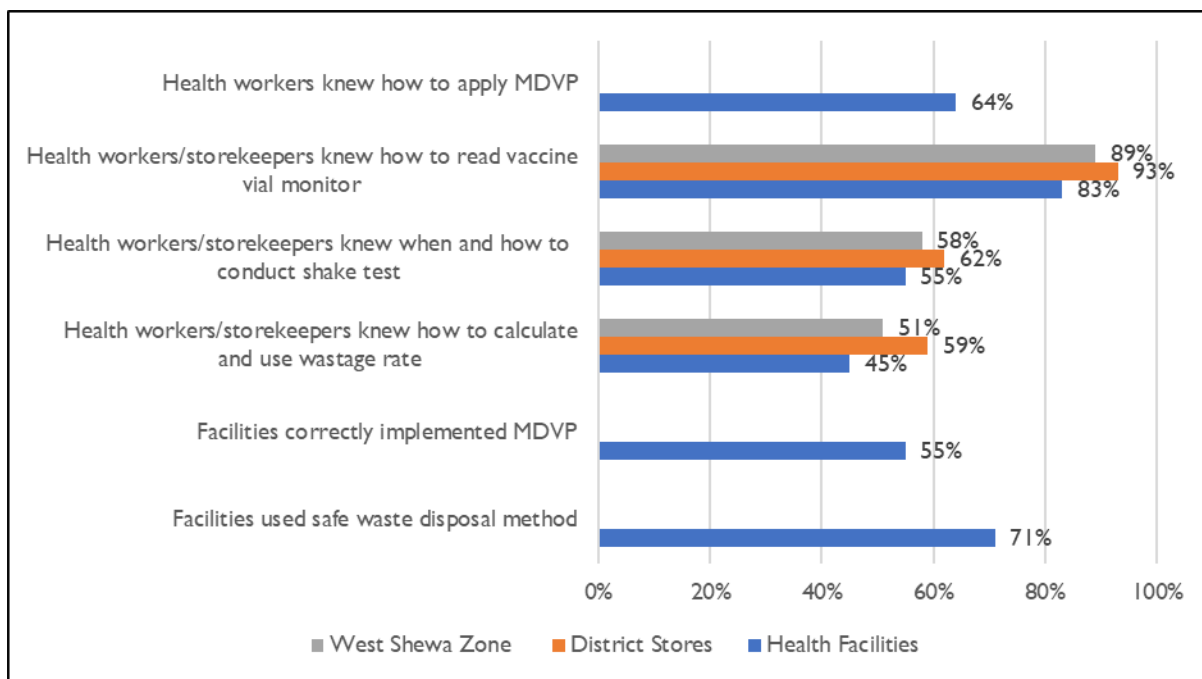
The consolidated score for vaccine management was 73% in West Shewa zone (Figure 6). The scores for the three levels of supply chain were within a narrow five-point range: 77% for the sub-national store, 74% for district stores and 72% for health facilities (Figure 6). Only 42.9% of district stores and 46.4% of health facilities scored above 80%.

Figure 6. Summary performance scores for vaccine management



Knowledge about specific vaccine management practices varied among health facility workers (Figure 7). Sixty-four percent of health workers knew how to use the multi-dose vial policy (MDVP) to determine which open vials of vaccine to keep or discard, 83% knew how to read a vaccine vial monitor and 55% knew when and how to conduct the shake test to check for frozen vaccines. However, only 45% knew how to calculate vaccines lost due to damage or neglect. Fifty-five percent of health facilities correctly applied MDVP and 71% used a safe method to dispose of vaccines.

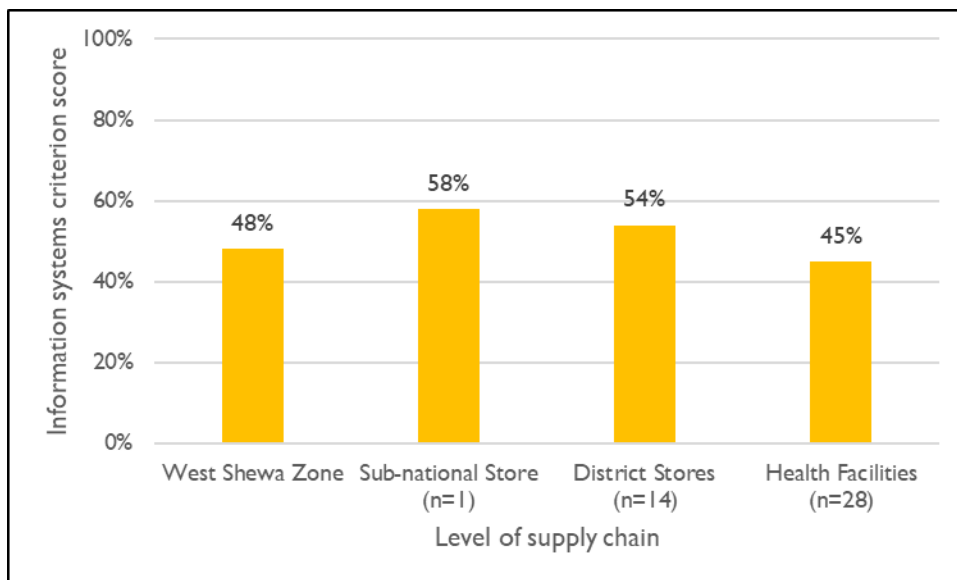
Figure 7. Performance scores for selected vaccine management indicators



**Information systems and management**

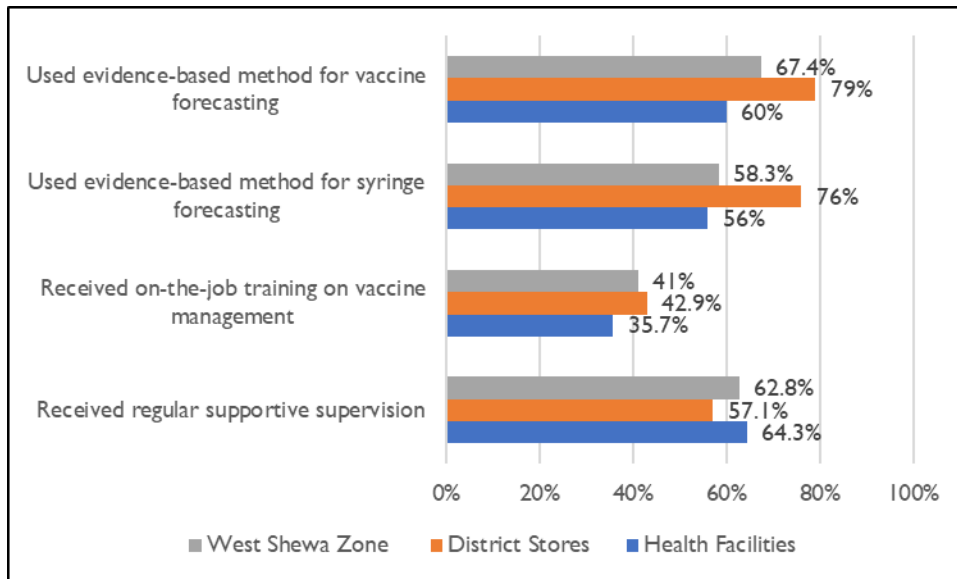
The overall consolidated score for information systems and management (ISM) was poor (48%) (Figure 8). The scores ranged from 45% for health facilities to 58% for the sub-national store (Figure 8). All the vaccine stores in the study received a score below 80% on information systems and management.

Figure 8. Summary performance scores for ISM



The performance score for evidence-based vaccine and syringe forecasting was below the acceptable score at both the district and health facility levels (Figure 9). Health facility staff had less access to on-the-job training for vaccine management than staff at district stores (35.7% and 42.9%, respectively), however health facilities scored higher on regular supportive supervision than district stores (Figure 9). Supervision occurred an average of twice a year.

Figure 9. Performance scores for selected ISM indicators



Key informants highlighted a disparity in training opportunities between upper- and lower-level staff. As an MCH Coordinator at a health center explained: *“In my opinion, information dissemination is not uniform. Training is only offered to wereda [district] personnel. Generally, little attention is given to EPI [staff].”*

## Discussion

This study assessed the performance of the immunization supply chain in West Shewa zone, Ethiopia. The results showed that West Shewa zone did not reach the WHO-recommended minimum standard of 80% for any criterion of effective vaccine management. The sub-national store and the district stores scored at least 80% on three criteria: temperature monitoring and building, cold chain equipment and transport at the sub-national store and storage capacity at district stores. Health facilities received low scores on all criteria, except distribution, compared to higher-level stores.

Overall, the zone's strengths were storage capacity (75%), temperature monitoring (74%) and vaccine management (73%). The main weaknesses were stock management (55%), information systems and management (48%) and maintenance of building, cold chain equipment and transport (43%). The findings in West Shewa were similar to the Ethiopian national assessment conducted in 2013 in only two ways: storage capacity was a strength in both assessments and stock management was a weakness in both our local and the national assessment (7). Our findings diverged from the national results in showing temperature monitoring and vaccine management were fairly strong in West Shewa zone compared to the rest of the country (7). Improvements in temperature monitoring at the local level may be due to corrective actions taken following the national assessment.

### Storage capacity

The zone scored comparatively well on storage capacity. District stores in West Shewa zone performed considerably better than district stores in Mozambique (49%), Uganda (75%) and Kenya (66%) (13-15). Our study also found that 93% of district stores and 82% of health facilities had adequate storage capacity at 2° to 8°C. By comparison, the national assessment showed that 79% of district stores and 93% of health facilities had adequate storage capacity at the required temperature range (7).

### Temperature monitoring

Temperature monitoring was one of the better performing areas in West Shewa zone, with scores ranging from 73% at the health facility level to 90% at the sub-national store. Our findings were stronger than the EVM assessment in Mozambique (13), where temperature monitoring scores were 69% and 52% at district and health facility levels, respectively.

Health workers in West Shewa zone out-performed their counterparts in the southeast and central regions of Ethiopia on knowledge of two important indicators of vaccine temperature monitoring: recommended temperature range and vaccines damaged at freezing temperatures. Eighty-six percent of health facility workers in this study knew the WHO-recommended temperature range for vaccine storage (2° to 8°C), compared with 67.8% of health workers in southeast Ethiopia (11) and 78.4% of health workers in central Ethiopia (8). Likewise, 79% of health workers in this study knew which vaccines on the Expanded Program for Immunization schedule could be damaged at freezing temperatures, compared with 60.1% of health workers in the southeast region of the country (11).

The WHO recommends recording storage temperature at least twice a day to ensure that the temperature is within the acceptable range, detect conditions which may cause vaccine damage and take necessary actions. This study found that storage temperature was recorded twice daily for each equipment in 64.3% of health facilities and 71.4% of district stores. This finding was slightly higher than results from central and southern Ethiopia that showed that temperature was recorded twice daily in 57.8% of health facilities (12), but lower than the results of another study from central Ethiopia (including Oromia, Amhara and Southern Nations, Nationalities and Peoples' regions) showing that 92.9% of health facilities recorded the temperature twice daily (8).

### **Vaccine management**

Health facilities in West Shewa zone performed better on vaccine management (72%) than health facilities in the national assessment (61%) (7). This study revealed 55% of health workers knew when and how to conduct the shake test – comparable to studies conducted in southeast Ethiopia (55.2%) (11) and Benishangul-Gumuz (52.3%) (9). Our study also showed that 64% of health workers could explain how to apply the Multi-Dose Vial Policy (MDVP). This finding was better than studies in central (8) and southeast (11) Ethiopia where only 31.9% and 20.8% of respondents, respectively, knew the preconditions for applying the MDVP. The wide disparity in knowledge found between our study and those conducted in central and southeastern Ethiopia may be due to differences in the training and professional background of study respondents: 84.5% of respondents in central Ethiopia (8) and 79.8% in southeast Ethiopia (11) were health extension workers, whereas the participants in our study were higher-level professionals.

### **Stock management**

Stock management is the most critical component of effective vaccine management. Yet, West Shewa zone received one of the worst scores on this criterion (55%), and health facilities performed the worst (40%). Similarly, the national EVM assessment in 2013 found weak stock management in Ethiopia (8). Our findings were comparable with EVM assessment reports from Mozambique (13) and Uganda (14), where stock management at health facilities scored 38% and 50%, respectively.

### **Information systems and management**

The EVM criterion score was also very low for information systems and management, ranging from 58% at the sub-national store to 45% at health facilities. This finding was supported by the national assessment which showed incomplete and untimely reporting of EPI data, inadequate triangulation of information, weak data verification efforts, poor forecasting capacity and a shortage of adequately trained EPI service providers and managers as factors contributing to weaknesses in the management of information systems in Ethiopia (7). Our findings were consistent with EVM assessments from developing countries that showed very poor performance on this criterion, especially at district and health facility levels (13-16).

Our study revealed that the use of evidence-based forecasting for vaccines and syringes was low in West Shewa zone, especially at health facilities. Wastage monitoring was also inadequate at health facilities. This might be related to poor recording of damaged vaccines and inadequate internal reviews of vaccine loss (42% at district stores and 29% at health facilities). This finding was supported by the national EVM assessment that showed that forecasting was poor at lower



levels in Ethiopia (7). In addition, stores at all levels failed to define the maximum and minimum amounts of each vaccine needed, possibly leading to overstocking and/or understocking.

Supportive supervision, provision of written feedback and training were also found to be inadequate. Supportive supervision should take place at least once per quarter. However, 57.1% of district stores and 64.3% of health facilities received supportive supervision an average of twice a year. This finding was stronger than southeast Ethiopia, where only 40.5% of health facilities received supportive supervision from district health offices (11).

Also, only 42.9% of district storekeepers and 35.7% of health workers received training on vaccine management. This finding was in line with a study done in central Ethiopia that showed only 42.5% of respondents reported receiving on-the-job training (8) and better than results from southeast Ethiopia that showed only 21.9% of vaccine providers received training on cold chain management (11).

### **Maintenance**

In this study, maintenance of building, cold chain equipment and transport received the lowest consolidated score at 43%. Health facilities performed the worst (40%). Similarly, national EVM assessments in east and southern Africa have reported poor maintenance of buildings and equipment at all levels of the supply chain, especially at the service provision level (13-15).

Our study showed that 19.5% of refrigerators at health facilities were non-functional. However, a higher proportion of refrigerators were non-functional in southeast (37.5%) and central Ethiopia (42.1%) (11, 8). In addition, a national cold chain equipment inventory found that refrigerators were non-functional in 34% of health facilities (7). West Shewa's comparably better showing on this indicator may be explained by convenient access to maintenance and repair services for refrigerators from the zonal office. However, these services were not available for other cold chain equipment or buildings.

### **Conclusion and recommendation**

Our study found that the immunization supply chain in West Shewa zone was poor, particularly in the areas of stock management, information systems and management and maintenance of building, cold chain equipment and transport. Despite their weak performance, the vaccine stores in this study fared comparably to, and in some cases, better than stores in central and southeastern Ethiopia on indicators ranging from twice daily recording of temperatures to supportive supervision. In-service training, computerized vaccine stock management systems and the installation of solar refrigerators may improve the immunization supply chain in this region.

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