COLLEGE OF MEDICINE AND HEALTH SCIENCES SCHOOL OF NURSING

VACCINE COLD CHAIN MANAGEMENT PRACTICE AND ITS ASSOCIATED FACTORS IN PUBLIC HEALTH INSTITUTIONS OF WEST ARSI ZONE, OROMIA, ETHIOPIA, 2023

MSc THESIS

BY: ABDO HAJO JARSO (BSc)

NOVEMBER, 2023

HAWASSA, ETHIOPIA

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BY: ABDO HAJO JARSO (BSc)

ADVISORS: MR. TOMAS YEHEYIS (MSc, ASSISTANT PROFESSOR)

MR. AMDEHIWOT AYNALEM (MSc)

A THESIS SUBMITTED TO SCHOOL OF NURSING, COLLEGE OF MEDICINE AND HEALTH SCIENCES, HAWASSA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN PEDIATRIC AND CHILD HEALTH NURSING

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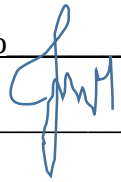
Declaration

I hereby declare that this MSc thesis is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis have been duly acknowledged.

Name: Abdo Hajo



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This is to certify that the thesis entitled "Vaccine Cold Chain Management Practice And Its Associated Factors In Public Health Institutions Of West Arsi zone, Oromia, Ethiopia, 2023" submitted in partial fulfilment of the requirements for the degree of master's with specialization in Pediatrics and Child Health Nursing, the graduate program of the school of nursing and has been carried out by Abdo Hajo under my/our supervision. Therefore I/we recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the school.

Mr Tomas Yeheyis (MSc, Assistant Professor)

Name of major advisor _____ Signature _____ Date

Mr Amdehiwot Aynalem (MSc)

Name of co-advisor _____ Signature _____ Date

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We, the undersigned, members of the Board of Examiners of the final open defence by Abdo Hajo have read and evaluated his/her thesis entitled **"**Vaccine Cold Chain Management Practice And Its Associated Factors In Public Health Institutions Of West Arsi Zone, Oromia, Ethiopia, 2023", and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfilment of the requirements for the degree of Master's with specialization in Pediatrics and Child Health Nursing, the Graduate Program of the School of Nursing.

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Table of Contents

ACRONYMS AND ABBREVIATIONS

BCG	Bacilli Calamite Guerin
BSc	Bachelors of Sciences
CCE	Cold Chain Equipment
CCEOP	Evaluation of the Cold Chain Equipment Optimization Platform
CCH	Cold Chain Handler
CCM	Cold Chain Management
CCMP	Cold Chain Management Practice
CCP	Cold Chain Point
CDC	Centre for Disease Control
CSA	Central Statistical Agency
DF	Deep Freezer
EPI	Expanded Program of Immunization
EVMAT	Effective Vaccine Management Assessment Tool
FEFO	First Expire First Out
GAVI	Global Alliance for Vaccine and Immunization
HC	Health Center
HP	Health Post
ILR	Ice Lined Refrigerator
IPV	Injectable Polio Vaccine
NGO	Non-Governmental Organization
OPV	Oral Polio Vaccine
PCV	Pneumococcal Conjugate Vaccine
PHCF	Primary Health Care Facilities
PQS	Performance Quality and Safety
PV	Penta-valent Vaccine
SNNP	Southern Nation Nationalities and Peoples
SPSS	Statistical Package for Social Sciences
UNICEF	United Nations International Children's Emergency Fund
VPD	Vaccine Preventable Disease
VVM	Vaccine Vial Monitoring
WHO	World Health Organization

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ABSTRACT

Background: In spite of high immunization coverage still there is high range of child mortality due to vaccine preventable diseases (VPDs).This problem is attributed to reduced vaccine potency resulted because of failure in cold chain management system which is less considered in developing countries including Ethiopia, particularly in this study area.

Objective: The aim of this study was to assess vaccine cold chain management practice and its associated factors in public health institutions of west Arsi zone, Oromia, Ethiopia 2023.

Methods: A facility-based cross-sectional study was conducted in all health institutions of randomly selected woredas in the west Arsi zone. A structured self-administered questionnaire and on-spot observation checklists were used to collect data from the healthcare facilities. Epi-data version 4.6.0.6 was used for data entry and Statistical Package for Social Sciences (SPSS) version 26 was used for analysis. The bivariate and multiple logistic regression analyses were conducted. Adjusted odd ratio (AOR) with a 95% confidence interval (CI) was used to determine the strength of association and the level of significance was set at P-value < 0.05.

Result: In this study, more than half (54.1%) of the public health institutions had good vaccine cold chain management practices. Good knowledge of vaccine handlers Adjusted Odds Ratio(AOR) (95% Confidence Interval(CI) = 3.85(1.32-11.25), regular supportive supervision AOR (95% CI)= 4.81(1.60-14.4), availability of Expanded program of immunization (EPI) guideline in healthcare facilities AOR (95% CI)= 5.21(1.67-16.3), no workloads AOR (95% CI)= 3.20(1.06-9.71) and using of vaccine request format AOR (95% CI)= 3.67(1.21-11.10) were positively associated with good vaccine cold chain management practice.

Conclusion: Vaccine handlers working in the study area of public health facilities had poor vaccine cold chain management practice. Enhancing the knowledge of vaccine handlers, providing guidelines, vaccine request forms, supportive supervision, and monitoring their practice toward cold chain management may help to improve practice towards vaccine cold chain management.

Key Words: Healthcare facilities, Vaccine cold chain management**,** Vaccine handlers, West Arsi

1. INTRODUCTION

1.1. Background of the study

Ethiopia adopted the world health organization(WHO's) EPI in 1980 with the goal of reducing infant mortality, morbidity and disability from VPD (Mulatu, Tesfa and Dinku, 2020a; Ababa, 2021; Gedlu *et al.*, 2021). EPI includes vaccine monitoring, immunization techniques, cold chain management, and reporting systems(Bogale, Amhare and Bogale, 2019; Mulatu, Tesfa and Dinku, 2020a).

Vaccination is the intervention used to prevent and eradicate VPDs, and the most cost-effective preventative health intervention which is valuable gift that a health care worker can give a child to protect them from disease-causing pathogens(Woldemichael, Bekele and Esmael, 2018; Bogale, Amhare and Bogale, 2019). It is critical in preventing between two and three million deaths worldwide each year(Mulatu, Tesfa and Dinku, 2020a).

Vaccines are ultrasensitive biological products which lose effectiveness while exposed to temperatures just above the recommended values(Manual, 2015; Mulatu, Tesfa and Dinku, 2020a; Mohammed, Workneh and Kahissay, 2021a; Gebretnsae *et al.*, 2022).Vaccines exposed to temperatures outside the recommended values may lost potency, resulting in limited protection(Woldemichael, Bekele and Esmael, 2018; Feyisa *et al.*, 2022) and the revaccination of patients as well as wastage of thousands of dollars(Information, 2022). Proper vaccine forecasting, procurement, handling, storage, and distribution are essential in order to provide effective vaccines to safeguard children from VPDs, and also the key prerequisite for the achievement of these strategies and programs is the populations' access to an appropriate supply of high-quality vaccines, that can only be ensured through the provision of safe vaccine via effective cold chain management systems(Ababa, 2020).

The system used for storing & distributing vaccines in good condition is called the cold chain or vaccine supply chain. It consists a series of links that are designed to keep vaccines within WHO recommended temperature ranges between +2°C and +8°C in the refrigerators from the point of manufacture to the point of administration(Manual, 2015; Vaccine, 2015; Woldemichael, Bekele and Esmael, 2018; Bogale, Amhare and Bogale, 2019; Feyisa *et al.*, 2022; Haldar, Majumdar and Ghosh, 2022; Information, 2022). To ensure a fully functional cold chain system, a range of technologies including cold and freezer rooms, refrigerators,

freezers, cold boxes, vaccine carriers, ice packs, temperature monitoring devices, and replacement parts are highly required.(Division, 2018).

At the health facility level (usually health centres and health posts), vaccine handlers can adequately protect vaccines by; keeping vaccines in appropriate vaccine refrigeration equipment, using a temperature-monitoring device all time to ensure temperatures remain between +2 ºC and +8 ºC, transporting vaccines to immunization sessions in a vaccine carrier, correctly packed, using coolant-packs that have been properly prepared, and during immunization sessions, fit a foam pad at the top of the vaccine carrier. Also one trained person must have overall responsibility for managing the vaccine cold chain and a second person can fill in when the primary person is absent(Manual, 2015). From 2010 to 2014, the percentage of low- and lower-middle-income countries meeting the threshold vaccine management standard recommended by the WHO showed temperature monitoring were(14%), storage capabilities(43%) ,building/equipment/transport(28%), maintenance systems(8%), stock management(18%), delivery(15%), vaccine management(33%) and information systems were(29%)(Importance *et al.*, 2010).

Despite the fact that so many countries in the world achieved high vaccination coverage it has also been reported that maintaining quality of vaccines has been one of the main challenges of immunization programs in Africa(Yassin *et al.*, 2019). Weaknesses in cold chain management are usually observed during vaccine transportation and storage(Mulatu, Tesfa and Dinku, 2020a).

1.2. Statement of the problem

Major outbreaks of VPDs have been caused by cold chain failure(Loharikar *et al.*, 2018)that was the reason for about 5.6 million death of under five children annually, accounting for 15% to 25% (15,000 deaths per day) of all under-five mortality(Mohammed, Workneh and Kahissay, 2021a).

Appropriate utilization of the cold chain system and adequate coverage rates are viewed as measures of goal attainment(Kumar and Gupta, 2020). The Centre for disease control (CDC) has estimated that each year, 300 million pounds worth of vaccines alone are destroyed globally due to improper storage and distribution(Ogboghodo *et al.*, 2017; Feyisa *et al.*, 2022)

In 2014, 20% of healthcare facilities in low- and lower-middle-income countries lacked the cold chain equipment necessary to preserve vaccines and guard against heat damage. Only 2% of the medical facilities with the necessary equipment had a working cold chain that made use of the best available cold chain technologies. Vaccines were at risk of temperature damage in the 78% of facilities that still had cold chain equipment that was either non-operational or made use of outdated technology(Importance *et al.*, 2010). Besides that, only 15% of these countries met the requirements for effective vaccine distribution down the supply chain(Importance *et al.*, 2010).

According to Global Alliance for Vaccine and Immunization (GAVI's) assessment from 2015, up to 90% of health care facilities in some countries lack any temperature monitoring equipment or are only equipped with outdated refrigerators that pose a high risk of freezing or temperature excursions(Division, 2018).

In three countries—Guinea, Kenya, and Pakistan—the prospective evaluation of cold chain equipment optimization platform (CCEOP) was conducted between 2018 and 2021, and this cross-country report found that Guinea fell far short of the WHO-recommended minimum standard of 80% in terms of the number of human resources available in rural health centres, the amount of cold storage available at the district and health centre levels, the accessibility of rural health centres, the quality of the data, and the use of effective vaccine management.(Team and Alliance, 2022). There are significant gaps in the cold chain, especially at the sub-county and facility levels, where the majority(81.1%) of the cold chain equipment (CCE) does not meet the performance, quality, and safety (PQS) standards established for the Kenyan immunization supply chain(Team and Alliance, 2022). Similar to how Pakistan's cold chain suffered from outdated equipment, weak distribution channels, a shortage of trained staff, a lack of trustworthy data, and an absence of comprehensive evaluations to facilitate concrete plans for improvement, effective vaccine management was well below the WHO-recommended minimum standard of 80%(Team and Alliance, 2022).

In developing countries like Ethiopia the cold chain system is at risk because of power supply, shipping, and skilled workforce are limited. Due to that healthcare institutions faced challenges to monitoring the temperature in the refrigerator, to store vaccines at the proper temperature, and transporting to end customers(Mulatu, Tesfa and Dinku, 2020a).

Various achievements have been made to improve cold chain management in Ethiopia; however, poor commitment of health professionals, staff work overload and its effects on exact and consistent record taking and sharing of information on vaccine temperatures; absence of adequate refrigerators, and vaccine carriers are all obstacles that continue to impact cold chain management (CCM) systems(Institute, 2018). Specifically, the recent national cold chain inventory report of Ethiopia, showed that: more than 3357 refrigerators have been used for over 10 years; about 5,997 refrigerators are 5-10 years old; 8,504 refrigerators are 1-5 years old; and 7668 refrigerators use kerosene as their energy source(Ababa, 2020; Gedlu *et al.*, 2021). Major contributing factors to cold chain weaknesses include transportation slowdowns, refrigerator quality, storage system, too long storage at the health unit, improper use of refrigerators, electric interruption, device breakage, and a lack or shortage of trained manpower capable of handling the cold chain(Mulatu, Tesfa and Dinku, 2020a) gender, professional experience, type and level of competence were stated(Umeta and Girma, 2021; Gebretnsae *et al.*, 2022).

The studies conducted in Amhara and Afar region revealed that, only 77% of health facilities in East Gojam zone(Bogale, Amhare and Bogale, 2019) and 19% in Afar(Gedlu *et al.*, 2021) have functional refrigerators. In Amhara region, about 42% of health facilities practice inappropriate CCM. A study in central Ethiopia showed that, only 58% of the health centres had a complete record on temperature, and 73% had non-working refrigerators. In addition, knowledge gap remains a significant challenge for effective CCM delivery(Bogale, Amhare and Bogale, 2019). Also, a study conducted in Oromia, Southern Nations, Nationalities and Peoples (SNNP) and Amhara Regions showed only 56% of health workers exhibited satisfactory levels of knowledge about CCM and practices(Gedlu *et al.*, 2021).

Even though the Ethiopian Ministry of Health has been implementing various methods to improve the accessibility and coverage of immunization services by installing solar refrigerators in primary healthcare facilities, there is little data available on the status of the cold chain and vaccine management in the study area. Studies that have been done so far were mainly focused on the service coverage, failing to mention concerns about cold chain management practices in the study area. The purpose of this study is to assess the cold chain management system practice and its associated factors in public health institutions of west Arsi zone, Oromia, Ethiopia.

1.3. Significance of the study

The findings of this study can be used as a scientific information for woreda, zonal/regional health officials and policymakers to establish evidence-based measures to strengthen the cold chain management system which is crucial to maintain vaccine potency and thereby reduce child mortality from VPDs. Also it may help health care workers' to be aware of their actual status of knowledge and practice on cold chain management and improve their performance. Furthermore, the findings from the current study can be used as a data source for researchers.

2. REVIEW OF THE LITERATURES

2.1. Vaccine Cold Chain management practice

According to the WHO, up to 25% of all vaccine products arrive at their destination in a degraded condition. Every country that monitored vaccine temperatures for surveillance experienced problems with the cold chain, so they are not necessarily limited to developing countries. As stated by the CDC, improper distribution and storage lead to the annual destruction of 300 million pounds worth of vaccines worldwide(Feyisa *et al.*, 2022).

In a study carried out in West Bengal, India, the cold box and vaccine carrier were correctly stored in the store in every cold chain point (CCP). Ice lined refrigerator (ILR) and deep freezer (DF) were correctly positioned on a wooden stand, 10 cm away from the wall and any nearby equipment. Additionally, a working thermometer was correctly positioned inside a basket, and the temperature was recorded twice daily, including on Sundays and holidays. Likewise, diluents and vaccine vials were correctly placed in ILRs. In this study, it was discovered that 60% of the CCP had the ILR and DF placed in accordance with WHO recommendations(Haldar, Majumdar and Ghosh, 2022).

A cross sectional study done in Cameroon stated that 26.9% and 12% of vaccine fridges were exposed to overheating (temperature higher than 8°C) and cold (temperature lower than +2°C) in the two previous months of data collection time(Yakum *et al.*, 2015).

The findings of a study carried out in Nigeria's Oyo state showed that incorrect handling practice, such as storing injections with vaccines, were used by 13.7% of participants, while 66.1% demonstrated good vaccine management practice(David M Dairo and Osizimete, 2016a). Another finding in Osun state showed that only 27.3% of facilities had daily temperature recording charts while 45.5% maintained refrigerators within normal ranges. A 81.8% of health facilities store vaccines and other items separately, and 63.6% of them arrange vaccines in accordance with the FEFO principle(Ojo *et al.*, 2019).

Only 23.5% of PHCFs in a recent study in Tigray, northern Ethiopia, correctly recorded daily temperatures, while 70.6% and 11.8% recorded at least one temperature outside the recommended range and took corrective action, respectively. Only 30% of PHCFs used the standard vaccine requisition format, which can result in an over or understock of vaccines.

Results show that only 48% of vaccine handlers had good knowledge of the cold chain and vaccine management in general.(Gebretnsae *et al.,* 2022).

Another finding of the study carried out in Bahir Dar city reveals that of the total health facilities, 71.4% had monitor temperature twice daily, while in 21.4% of the facilities, expired vaccines were found in the refrigerator during data collection(Mulatu, Tesfa and Dinku, 2020a). Similarly, an East Gojam study found that 58.3% and 43.8% of health facilities consistently recorded temperature twice daily and followed the first expired first out (FEFO) principle, respectively. Furthermore, the overall cold chain management practice was 58.3%(Bogale, Amhare and Bogale, 2019).

A study conducted in Southern Ethiopia's Gurage Zone realized that 85.7% of functional fridge tags indicated the recommended temperature range. On the other hand, laboratory reagents and maternity medicines were found alongside vaccines in 25% of health facilities.(Yassin *et al.,* 2019).

Another study on cold chain status and vaccine provider knowledge in Southeast Oromia Bale Zone found that only 20% of health facilities had temperature recording sheets, with 42.8% recording twice daily. Similarly, in all functional refrigerators, the majority of thermometer readings (82.8%) were recorded outside of the recommended temperature range. Furthermore, a study found that only 40% of health facilities properly stored vaccines, while 42.9% and 45.7% used incorrect compartments for vaccine placements and stored non-vaccine items in refrigerators, respectively(Woldemichael, Bekele and Esmael, 2018).

2.2. Factors associated with vaccine cold chain management practice

2.2.1. Institutions related characteristics

A study done in Nigeria Oyo state reviled that among health workers who were aware of a vaccine handling and storage guideline 73% had good practices of vaccine cold chain(David M Dairo and Osizimete, 2016b).

According to a study conducted in Guraghe and Guji zones of Ethiopia, health professionals who use EPI guidelines are 2.58 times more likely to have adequate understanding of cold chain management than those who haven't used the guidelines(Yassin *et al.,* 2019; Degavi *et al.,* 2021). On the other hand, a study carried out in Tigray, northern Ethiopia, found that vaccine handlers who had gotten supportive supervision in the previous six months were

4.58 times more likely to have effective cold chain and vaccine management practices than those who hadn't(Id *et al.*, 2022).

Result of study done in Wolaita zone, Southern part of Ethiopia revealed that health care facilities with supportive supervision were 2.71-times more likely to have good cold chain management when compared to the facilities without supportive supervision(Offices *et al.*, 2023).

2.2.2. Socio-demographic and professional related factors

Professional type and educational level

A study conducted in Nigeria showed that community health officers were found to have practiced vaccine logistics management systems more significantly than the other (Public Health Nurses)(Adebimpe and Adeoye, 2021a).

Another research performed in Northern Ethiopia's east Gojjam found that nurses were about 17 times more likely than Health Extension Workers to have proper cold chain management practices. Besides this, it confirmed that among the factors, professional training and knowledge of vaccine cold chain management had a statistically significant association with the application of cold chain management by health care workers(Bogale, Amhare and Bogale, 2019).

A study done in Jimma zone, Oromia Regional state indicated that community health extension workers were 1.022 times more likely to have good practice of cold chain management compared to auxiliary nurses and registered nurses and with increasing level of education, practice of cold chain management was found to be better(Feyisa and Feyisa, 2022).

In a similar vein, another study conducted in the Guji zone of Oromia disclosed that BSC/HO professionals were 2.124 times more likely than other professionals to possess adequate knowledge of cold chain management(Degavi *et al.*, 2021).

Work experiences

A study conducted in Nigeria found that male gender and having more than five years of experience in the field were significant predictors of effective use of the immunization logistic management system(Adebimpe and Adeoye, 2021a). Similarly, when compared with their counterparts, health workers with more than two years of work experience were

about five times more likely to have proper cold chain management practices(Mulatu, Tesfa and Dinku, 2020b).

A study performed in Wolaita zone showed that facilities whose cold chain is managed by health workers with two or more years of work experience had 2.8-times higher odds of good cold chain management than its counterparts(Offices *et al.*, 2023). Study result of Jimma zone Oromia regional state stated that cold chain handlers' years of service in vaccine cold chain management showed significant associations with vaccine cold chain management practices(Feyisa and Feyisa, 2022).

Health workers with more than six years of experience were 2.2 times more likely to have adequate knowledge of cold chain management, according to a study carried out in the Oromia Guji zone(Degavi *et al.*, 2021).

Training

In Nigeria's Oyo state, a research discovered that those (61%) who had formal training in handling and storing vaccines had appropriate cold chain management habits(David M Dairo and Osizimete, 2016b). In a similar manner, a Tigray study revealed that vaccine handlers having cold chain and vaccine management training had five times greater understanding of how to handle vaccines(Id *et al.*, 2022).

A cross sectional study done in Amhara regional state of Oromia Special zone Showed that receiving of training on cold chain management had a statistical significant association with the level of knowledge on cold chain management (AOR = 3.04)(Ahmed *et al.*, 2021).

Recently a study conducted in Wolaita zone Southern part of Ethiopia expressed that health care workers who had taken in-service training on cold chain management were 1.86-times more likely to practice cold chain management than those who had not received in-service training(Offices *et al.*, 2023).

In accordance with another research done in the Guraghe and Guji zones of Southern Ethiopia and Southeast Oromia, health professionals who had received vaccination training were 5.10 and 6.13 times more informed about cold chain management, respectively(Yassin *et al.*, 2019; Degavi *et al.*, 2021).

2.2.3. Knowledge of vaccine handlers on cold chain management practice

However, vaccine handlers' knowledge is important factor in the proper operation of the cold chain system in order to avoid vaccine failure and sustain immunization effectiveness, in a study conducted on cold chain management in Cebu, Philippines, 77.3% of study participants did not understand the best method to store vaccines. Similarly, 59.1% of respondents did not know where the thermometer should be positioned in storage units, and the majority of respondents (95.5%) did not believe that improper transport and storage conditions posed a danger to vaccine quality and potency(Maglasang *et al.*, 2018). In contrast, a study carried out in West Bengal, India, revealed that nearly all cold chain handlers (CCH) were knowledgeable about vaccine vial monitoring (VVM), the timing of using reconstituted vaccines, the placement of diluents inside ILRs, the conditioning of ice packs, the temperature range of ILRs and DFs, the shake test, the open vial policy, and freeze- and heat-sensitive vaccines(Haldar, Majumdar and Ghosh, 2022).

According to a study conducted in Oyo state, Nigeria, approximately 43.0% of vaccine handlers were knowledgeable about vaccine management(David M. Dairo and Osizimete, 2016). Another finding from the Nigerian state of Osun revealed that 54% and 19% of health care providers were knowledgeable about the shake test and could correctly interpret colour changes on VVM(Ojo *et al.*, 2019).

In a study done in Tigray, Northern Ethiopia, 64%, 12%, 52%, and 66% of respondents knew the proper interpretation of VVM stages, how to apply the shake test, the EEFO principle, and the status of expiration dates, respectively(Gebretnsae *et al.*, 2022). As per research carried out in the Amahara region, all study participants were aware of the WHO temperature range, which is 2 to 8°C, the interpretation of the VVM, and 85.7% of respondents were aware of the shake test's interpretation. Additionally, the results showed that 92.9% of respondents had good knowledge of vaccine cold chain management(Mulatu, Tesfa and Dinku, 2020a). In the same way a study carried out in East Gojam indicated that 58% of respondents knew VVM interpretation correctly while only 35% of storekeepers knew correct placing of thermometer in refrigerator. In general 38.3% of study participants had sufficient knowledge about vaccine cold chain management(Bogale, Amhare and Bogale, 2019).

The recommended temperature range (2°C-8°C) for vaccine storage and the frequency of temperature recording were correctly mentioned by 71.1% and 83.6% of health workers, respectively, according to a study done in Southern Ethiopia's Gurage Zone. This accounts for 51.3% of the workers' overall knowledge of cold chain management(Yassin *et al.*, 2019).

The results of a study conducted in the southeast Oromia Bale Zone, 67.8% and 57.9% of vaccine providers correctly responded to the recommended temperature range for vaccine storage and the recommended frequency of temperature recording per day, respectively. The majority of participants (89.1%) were unaware of the proper compartment for storing vaccine in the refrigerator. Only 36.2% of healthcare workers correctly identified the purposes and interpretations of the shake test and VVM. In general, 54.6% of respondents were rated to have adequate knowledge of cold chain management(Woldemichael, Bekele and Esmael, 2018).

In addition different studies conducted in Tigray, East Gojam, Silte Dalocha district, and Wolaita zone showed that health care workers who had a good knowledge were about 11, 2.14, 4.21, and 3.02 times more likely to practice cold chain management than those vaccine handlers who had poor knowledge respectively(Bogale, Amhare and Bogale, 2019; Feyisa *et al.*, 2022; Id *et al.*, 2022; Offices *et al.*, 2023).

2.2.4. Availability of cold chain equipments related factors

The findings of a study conducted in the Philippines revealed that storage units and equipment were available, despite the fact that only 22.7% of facilities were stored vaccines. Primary health care (PHC) did not have access to a generator in 90.9% of cases, and only 9% had a voltage stabilizer connected to the refrigerator. Refrigerators with temperature readings were found in only 68.2% of PHCs(Maglasang *et al.*, 2018).

According to a study done in West Bengal, India, deep freezers and ice-lined refrigerators were properly installed in 75% of cold chain points, while 40% of CCPs reported cold chain equipment (CCE) failure in the previous year.(Haldar, Majumdar and Ghosh, 2022). Cross sectional study conducted in Cameroon indicated that 81.5% of health facilities had at least one functional vaccine refrigerator(Yakum *et al.*, 2015).

The study's findings in Oyo state, Nigeria, disclosed that unstable power systems (86%), an absence of fuel for generators (64%), a lack of backup refrigerators (52%), a lack of ice

packs for maintaining cold temperatures (49%), the high cost of transporting vaccines (47%), and a insufficiency of cold boxes (40%) were cited as the major challenges faced by vaccine handlers in terms of storing vaccines(David M. Dairo and Osizimete, 2016). Similar to that, a study conducted in the Osun state, Nigeria indicated that only 45.7%, 37.1%, and 31.4% of the facilities had cold boxes, thermometers, and functional refrigerators for storing vaccines, respectively(Ojo *et al.*, 2019).

According to a study carried out in Tigray, northern Ethiopia, only 42% of primary health care facilities (PHCFs) had access to an electrical power supply, but 54% of PHCFs had working temperature monitoring equipment. Besides that, it indicated only 48%, 32 %, and 28 % of the PHCFs, respectively, had a vaccine stock register, a vaccine request format, and a temperature recording chart(Gebretnsae *et al.*, 2022).

Another studies carried out in northern Ethiopia Bahir Dar city and East Gojam indicated that 64.3%, and 76.7% had functional thermometer while 71.4%, and 35% had functional generator for backup service respectively(Bogale, Amhare and Bogale, 2019; Mulatu, Tesfa and Dinku, 2020a). In addition, a study of East Gojam confirmed that only 13.3% of facilities had a separated store for storing vaccines, and 46.6% of them had a car or motorcycle for transporting vaccines in the event of a refrigerator or power interruption(Bogale, Amhare and Bogale, 2019).

Study conducted in southern Ethiopia, Gurage Zone showed that only 22.8% of health facilities had a refrigerator, while the remaining facilities transport vaccines from nearby health facilities that had a functional refrigerator using car/motorbike (62.5%)(Yassin *et al.*, 2019).

According to study conducted on health posts in West Shewa, Oromia Central Ethiopia, only 27.59% of health posts had a refrigerator, of which 37.5% were functional. Of total only 10.34% of the health posts had access to electricity(Umeta and Girma, 2021). Another research conducted in Southeast Oromia Bale Zone indicated 37.5% health facilities had no functional refrigerators at time of data collection even 58.9% have electric source power for refrigerator(Woldemichael, Bekele and Esmael, 2018).

2.3. Conceptual Frame Work

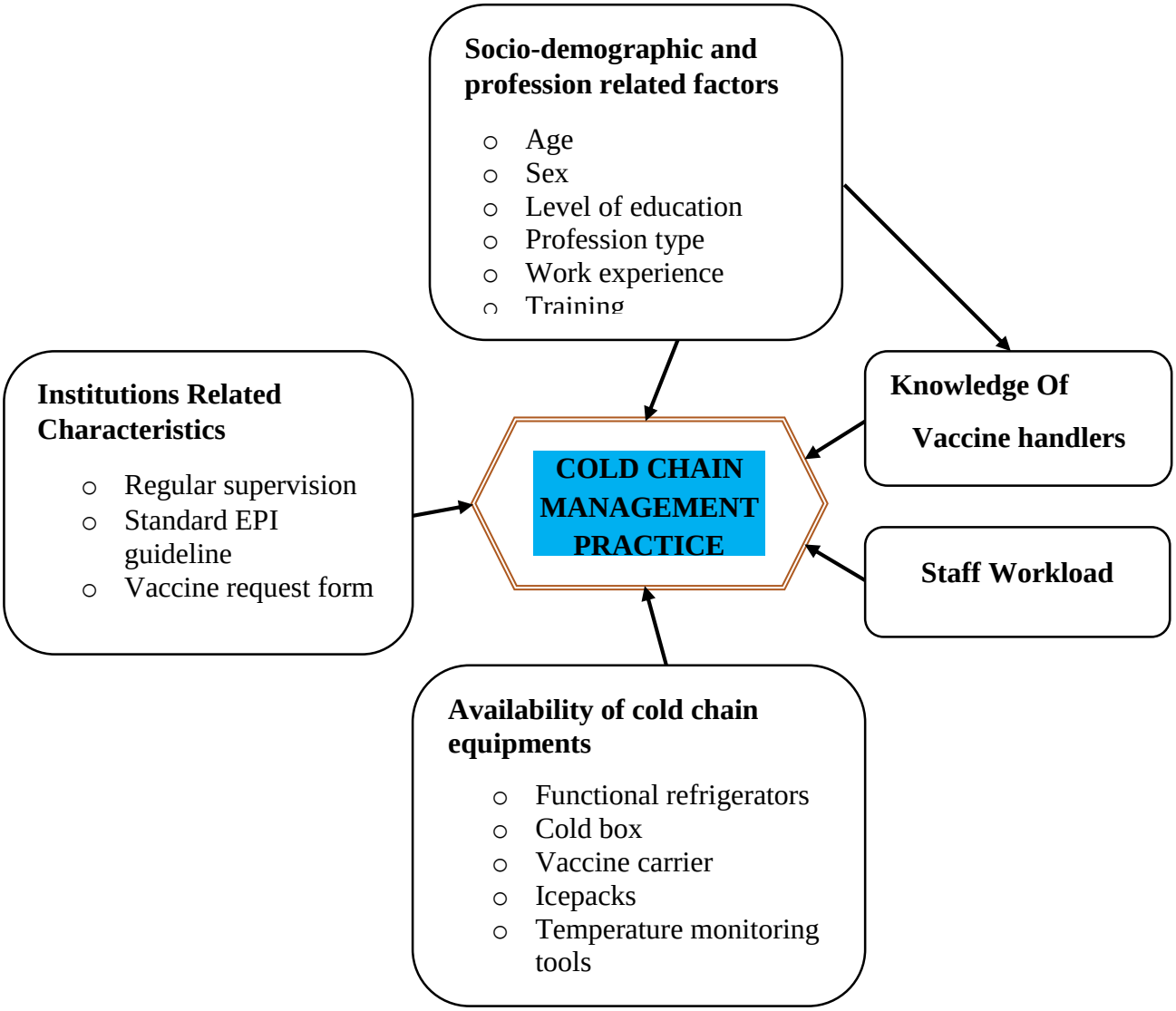

Figure: 1 Conceptual frame work of reviewed literatures on vaccine cold chain management practice and its associated factors in selected public healthcare institutions of West Arsi zone Oromia, Ethiopia,2023(Bale et al., 2018; Bogale, Amhare and Bogale, 2019; Ss et al., 2019; Mulatu, Tesfa and Dinku, 2020b; Mohammed, Workneh and Kahissay, 2021b; Feyisa et al., 2022; Id et al., 2022).

3. OBJECTIVES

3.1. General Objective

To assess vaccine cold chain management practice and its associated factors in public healthcare institutions of west Arsi zone, Oromia, Ethiopia, 2023.

3.2. Specific Objectives

- To determine the level of vaccine cold chain management practice in public healthcare institutions of west Arsi zone, Oromia, Ethiopia, from May 1-20, 2023.
- To identify factors associated with vaccine cold chain management practices in public healthcare institutions of west Arsi zone, Oromia, Ethiopia, from May 1-20, 2023.

4. MATERIALS AND METHODS

4.1. Study Area

This study was conducted in the West Arsi zone of Oromia regional state, which is found in southeast Ethiopia. The zone covers an area of 12556 km2, which comprises 13 districts and 4 town administrations. It shares a boundary line with East Shewa Zone to the north, SNNPs to the west, Guji to the south, Sidama Regional State to the southwest, Arsi Zone to the northeast, and Bale Zone to the east. Shashemene is the zonal town, which is 251 km from the capital, Addis Ababa. Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), this zone has a total population of 1,964,038. The population was officially estimated at 2,929,894 in mid-2022. The zone comprises a comprehensive specialised hospital, two general hospitals, four primary hospitals, eighty-eight health centres, 328 health posts, and several private healthcare institutions(Ss *et al.*, 2019).

Study Design and Period

A facility-based cross-sectional study was employed in selected public healthcare institutions of West Arsi Zone from May 1 – 20, 2023.

4.2. Population

Source Population

The source population for this study were all healthcare facilities of West Arsi Zone, 2023.

Study Population

The study population was selected public healthcare institutions of West Arsi zone, 2023.

4.3. Eligibility criteria

Inclusion Criteria

All public healthcare facilities that provide routine immunization services were included in the study.

Exclusion Criteria

Public healthcare facilities whose cold chain point was closed after three visits at the time of data collection were excluded.

4.4. Sampling

Sample Size Determination

The sample size of this study was all public healthcare institutions located in randomly selected woredas and city/town administration of West Arsi zone.

Sampling Procedure

There are 13 rural woredas and 4 town/city administrations in the zone. From this 4 rural woredas (Kofele, Shashemene, Siraro and Wando) and one city administration (Shashemene city administration) were selected randomly. All health institutions (1 general hospital, 1primary hospital, 29 health centres and 70 Health Posts) were included in the study(Feyisa, 2021; Gebretnsae *et al.*, 2022)

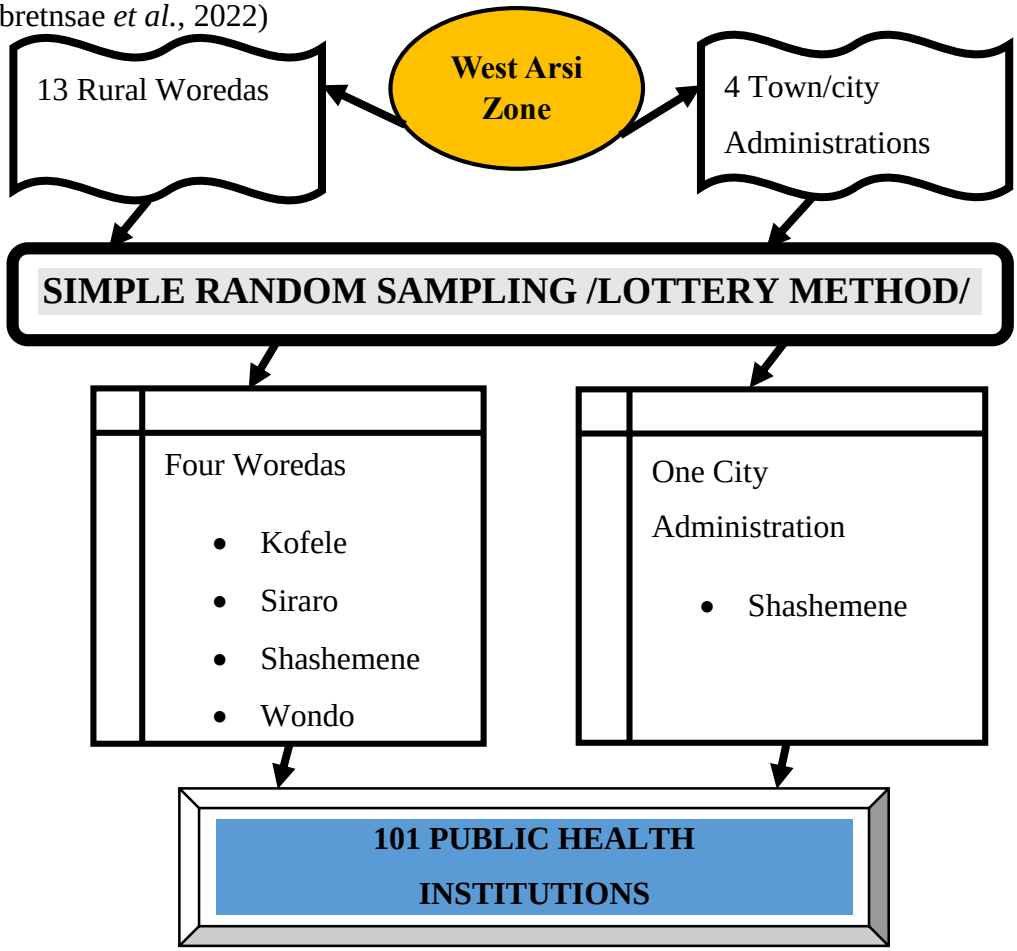

Figure 2: Sampling frame of the study on vaccine cold chain management practice and its associated factors in selected public healthcare institutions of west Arsi zone, Oromia, Ethiopia, 2023

4.5. Study Variables

4.5.1. Dependent Variable

- Vaccine cold chain management practice

4.5.2. Independent Variable

- Socio-demographic and profession related: - Age, sex, level of education, professional type and work experiences in year and training.
- Availability of cold chain equipments: - Refrigerators, freezers, cold box, vaccine carrier, icepacks, foam pads and temperature monitoring tools.
- Facility related characteristics: - Power source, regular supportive supervision standard EPI guideline, vaccine request format and transportation.
- Knowledge of vaccine handlers on cold chain management
- Staff work load/ insufficient staff

4.6. Data Collection and Analysis Plan

4.6.1. Data Collection Instruments

Structured self-administered questionnaire and on-spot observational checklist adapted from WHO and WHO-UNICEF-effective vaccine management assessment tool (WHO-UNICEF-EVMAT) was used to capture relevant information regarding practice and adherence of health facilities to the effective cold chain management(Vaccine and Management, 2005). The questionnaire was prepared in English language and translated in to local language Afan Oromo and then translated back to English by language expert for more understanding. The questionnaire has six different components such as: 1) Socio-demographic and profession related questions (sex, age, level of education, professional type, working experience, training), 2) availability of cold chain equipments (refrigerators, freezers, cold box, vaccine carrier, icepacks, foam pads and temperature monitoring tools), 3) institutions related variables (power source, trained man power, temperature monitoring chart, regular supportive supervision, request format and standard EPI guideline), 4) knowledge of vaccine handlers on vaccine cold chain management, 5) workload related variables and 6) vaccine cold chain management practice (placement of refrigerator, placement of vaccines in refrigerators, temperature range, status of VVM, shake test, FEFO) and other related variables.

4.6.2. Data Collection Procedure

The data was collected through self-administered questionnaire and on spot observational checklist of vaccine handlers and facilities. Document review was also conducted to check cold chain temperature monitoring, availability of recording and reporting tools. Five number of under-five focal persons who had experience in data collection and one EPI focal person were used from unselected woreda's as collectors and supervisor respectively.

4.6.3. Data Processing and Analysis

Collected data was checked for consistency and entered in to epi-data version 4.6.0.1. Then exported to SPSS version 26 for analysis. Descriptive statistics like frequency, cross tabulation and percentage calculations was done. Binary logistic regression analysis was carried out to assess the presence of association between predictor variables and the outcome variable. Variables with P-value < 0.25 in bivariate logistic regression was entered in to a multivariate logistic regression to control the effects of potential confounding factors. The fitness of the model was tested by Hosmer Lemeshow goodness of fit test at P-vale >0.05 and the model was fit that, 78.6% correctly classified the outcome variable as good and poor vaccine cold chain practice. Multi-collinearity among the predictor variables was checked by the Variance inflation factor (VIF) and no multi-collinearity was found (Min VIF= 1.046, Max VIF= 1.222). Also the Durbin-Watson test was done to test the presence of autocorrelations among independent variables but no autocorrelation detected (Durbin-Watson= 1.718). Finally presence and level of significant association was determined using adjusted odds ratio (AOR) with 95% CI and P<0.05.

4.7. Operational Definitions

Cold chain management Practice: Maintaining a network of refrigerators, cold boxes and vaccine carriers for keeping vaccines within the recommended temperature range (2°C - 8°C) to safeguard their potency during transportation, storage and delivery systems to ensure the uninterrupted availability of quality vaccines from manufacturer to service-delivery levels(Manual, 2015; Information, 2022).

Good vaccine handling practice: Health facilities and vaccine handlers that scored greater than or equal to 75% for practice questions(Feyisa *et al.*, 2022).

Poor vaccine handling practice: Health facilities and vaccine handlers that scored less than 75% for practice questions.

Good knowledge of cold chain management: Vaccine cold chain handler who scored 75% and above was labelled as having a satisfactory/good knowledge(Offices *et al.*, 2023).

Poor knowledge of cold chain management: Vaccine cold chain handler who scored below 75% was labelled as having unsatisfactory/poor knowledge.

Availability of necessary cold chain equipment: If the health care facilities (HCFs) had at least foam pad, two vaccine carriers and 8 ice packs(Gebretnsae *et al.*, 2022).

4.8. Data Quality Control

Pre-test was conducted on five percent of sampled study institutions outside of study areas (Nagelle Arsi woreda) in order to validate the questionnaire by performing Cronbach's Alpha test for each category of used tool which indicated that the minimum alpha value was 0.706 while the maximum value was 0.806. Then the questionnaire was revised accordingly based on the information obtained from the pre-test. Training focused on the study objectives, ways of data collection, and relevant ethical issues during data collection and supervision process was given for data collectors and supervisors. During data collection data was checked for its completeness and missing information at each point with data collectors and supervisors themselves. Principal investigator closely supervised overall tasks of data collection and checked the collected data during entry before performing analysis and made needed corrections accordingly.

4.9. Ethical Consideration

Ethical clearance was obtained from Hawassa University, College of Health Sciences Institutional Ethical Review Board (Ref. No: IRB/303/15). Permission letter was taken from School of Nursing and submitted to Oromia Regional Health Bureau. Then, a permission letter was written down to West Arsi Zone Health Office and Shashemene City Health office. Then after a support letter was written to each woreda health offices and selected hospitals where the study was conducted. During data collection, each participant was informed about the purpose of the study and assured for confidentiality. Then written consent was taken from each respondent after they are willing to proceed.

4.10. Dissemination Plan

The final report will be submitted to the Hawassa University College of Medicine and Health Sciences, School of Nursing. After its approval, the findings of this study will be communicated to the Oromia Health Bureau and West Arsi Zone Health Office. In conclusion, an attempt will be made to publish in a reputable journal.

5. RESULTS

Ninety-eight selected public health institutions in the west Arsi zone were included in the study, with a response rate of 97.03. Of the total public health institutions included in the study, 67(68.4%) were health posts, 29(29.6%) were health centres, and 2(2%) were hospitals.

5.1. Socio-demographic and professional related Characteristics

Among the vaccine handlers included in the study, the majority of them 86(87.8%) were female, 70(70.4%) were HEW, 20(20.4%) were nurses, and 8(8.2%) were midwives. In terms of educational level, 63(64.3%) were level III HEWs, 15(15.3%) of the respondents were diploma holders, and 20 (20.4%) were degree holders. Regarding the work experience of vaccine handlers, 85(86.7%) had >=2 years, while only 13(13.3%) of the respondents had < 2 years of work experience. Out of the total respondents, 86(87.8%) had received EPI training, of which 69(80.2%) took out-of-job training **(Table 1).**

Table 1: Socio-demographic and professional related characteristics of respondents towards vaccine cold chain management practice in selected public healthcare institutions of West Arsi zone Oromia, Ethiopia 2023 (N=98).

Variable	Category	Frequency	Percent
Age of respondents(n=98)	<25 years	20	20.4
	>=25 years	78	79.6
Sex of respondents(n=98)	Male	12	12.2
	Female	86	87.8
Marital status of respondents(n=98)	Unmarried	32	32.7
	Married	66	67.3
Residence of the respondents(n=98)	Urban	39	39.8
	Rural	59	60.2
Level of education(n=98)	Certificate/level III	63	64.3
	Diploma/level IV	15	15.3
	Degree and above	20	20.4
Professional type of the respondents(n=98)	HEW	70	71.4
	Nurse	20	20.4
	Midwifery	8	8.2
Work experiences(n=98)	<2 years	13	13.3
	>= 2 years	85	86.7
Having of training on EPI(n=98)	Yes	86	87.8
	No	12	12.2
Type of training(n=90)	On job training	17	19.8
	Out of job training	69	80.2

5.2. Institution related characteristics

Of the total PHCFs, 46(47%) had access to the main sources of power supply; out of these, 37(80.4%), were electric, and 9(19.6%) were solar power sources. Out of 46 institutions that had power supplies for refrigerators, only 38 of them stored vaccine; 36(94.7%) of them have permanently assigned personnel for vaccine cold chain management and temperature recording. Of all PHCFs, only 21(21.4%) of them had a standard vaccine request format, 47(48%) had regular supervision, and 65(66.3%) had an EPI guideline **(Table 2).**

Table: 2 Institution related characteristics of vaccine cold chain management practice in selected public healthcare institutions of West Arsi zone Oromia, Ethiopia 2023.

Variables	Category	Frequency	Percent
Main source of power for refrigerator(n=46)	Electricity	37	80.4
	Solar	9	19.6
Presence of permanently assigned personnel for cold CCMP(n=38)	Yes	36	94.7
	No	2	5.3
Presence of personnel assigned during holiday/weekend(n=38)	Yes	2	5.3
	No	36	94.7
Presence of temperature recording chart(n=38)	Yes	36	94.7
	No	2	5.3
Presence of standard vaccine request format(n=98)	Yes	21	21.4
	No	77	78.6
Presence of Motorbike for vaccine transportation(n=98)	Yes	35	35.7
	No	63	64.3
Presence of regular supervision(n=98)	Yes	47	48
	No	51	52
Giving feedback following supervision(n=47)	Yes	30	63.8
	No	17	36.2
Availability of EPI guideline(n=98)	Yes	65	66.3
	No	33	33.7

5.3. Knowledge of Vaccine Handlers on Cold Chain Management Practice

Regarding the knowledge of vaccine handlers 90(91.8%) of the respondents knew the recommended temperature range for most vaccines stored in refrigerators, 83(84.7%) knew the frequency of temperature monitoring and recording, 56(57.1%) correctly responded for the most heat-sensitive vaccine, and only 16(16.3%) knew the most freeze-sensitive vaccine. Accordingly, 57(58.2%) respondents had good knowledge, while others had poor knowledge of vaccine cold chain management practices **(Table 3).**

Table: 3 Knowledge on vaccine cold chain management practice among vaccine handlers in selected public healthcare institutions of West Arsi zone Oromia, Ethiopia 2023 (N=98).

Variables	Frequency	Percent
Know recommended temperature range in refrigerator	90	91.8
Don't know temperature range for refrigerator	8	8.2
Know recommended temperature range stored in Freezer	42	42.9
Don't know recommended temperature range stored in Freezer	56	57.1
Know frequency of temperature monitoring and recording	83	84.7
Don't know frequency of temperature monitoring and recording	15	15.3
Know most heat sensitive vaccine	56	57.1
Don't know most heat sensitive vaccine	42	42.9
Know most freeze sensitive vaccine	16	16.3
Don't know most freeze sensitive vaccine	82	83.7
Know the indication for VVM	64	65.3
Don't know the indication of VVM	34	34.7
Know the indication of shake test	61	62.2
Don't know the indication of shake test	37	37.8
Know indication of FEFO principle	49	50.0
Don't know indication of FEFO	49	50.0
Know recommended cool life for vaccine carrier	60	61.2
Don't know recommended cool life for vaccine carrier	38	38.8
Know recommended cold life for closed cold box	16	16.3
Don't know recommended cold life for closed cold box	82	83.7
Poor knowledge of vaccine CCMP	41	41.8
Good knowledge of vaccine CCMP	57	58.2

5.4. Staff work load

Regarding the presence of staff workload, 80(81.6%) of the respondents chose yes, 58(59.2%) and 56(57.1%) of them said workload and staff shortage can affect the practice of vaccine cold chain management, respectively **(Figure 3).**

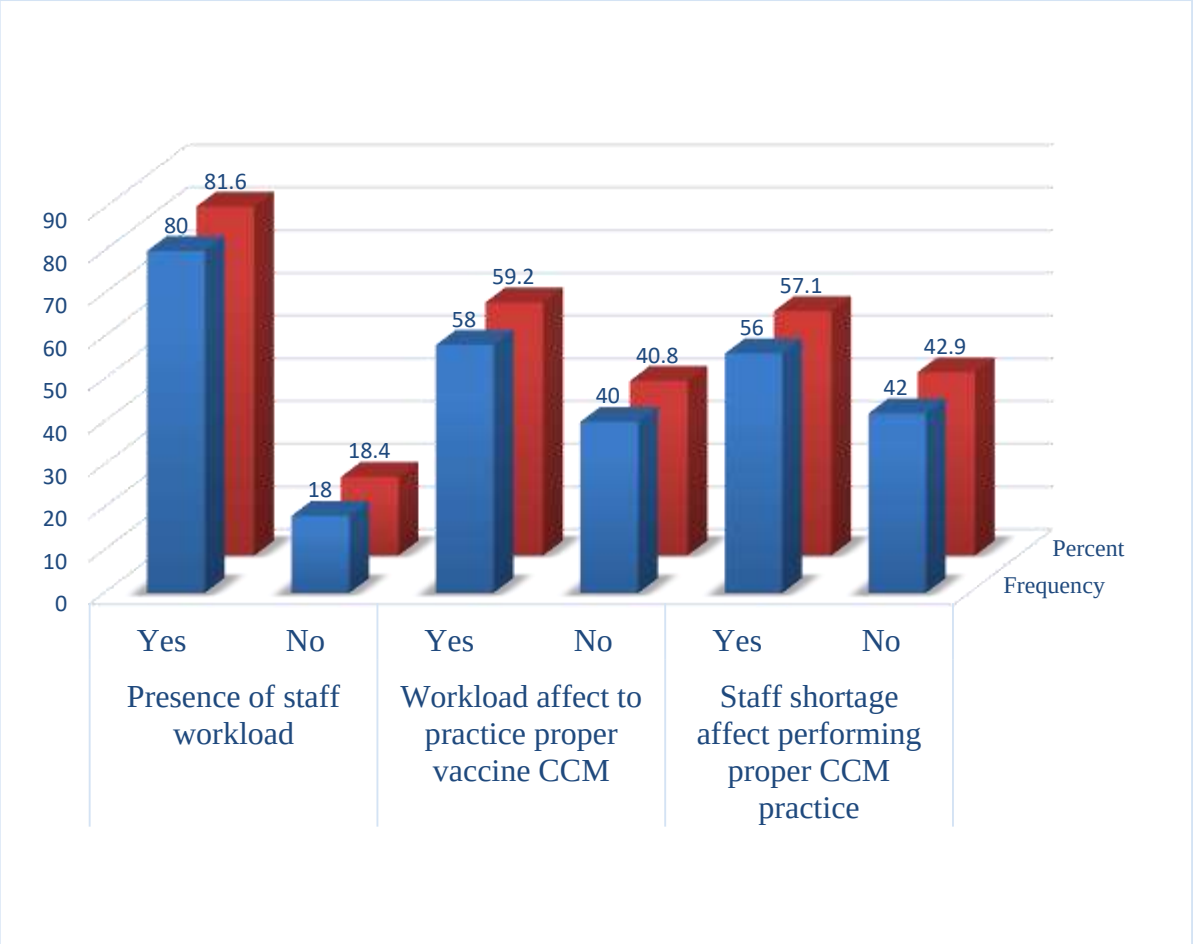

Figure: 3 Staff workload related factors on vaccine cold chain management practice in selected public healthcare institutions of West Arsi zone, Oromia, Ethiopia, 2023

5.5. Availability of Cold Chain Equipments

All public health institutions had vaccine carriers and foam pads, while around half had functional vaccine refrigerators, cold boxes, temperature monitoring tools, and other essential cold chain equipment. **(Figure 4).**

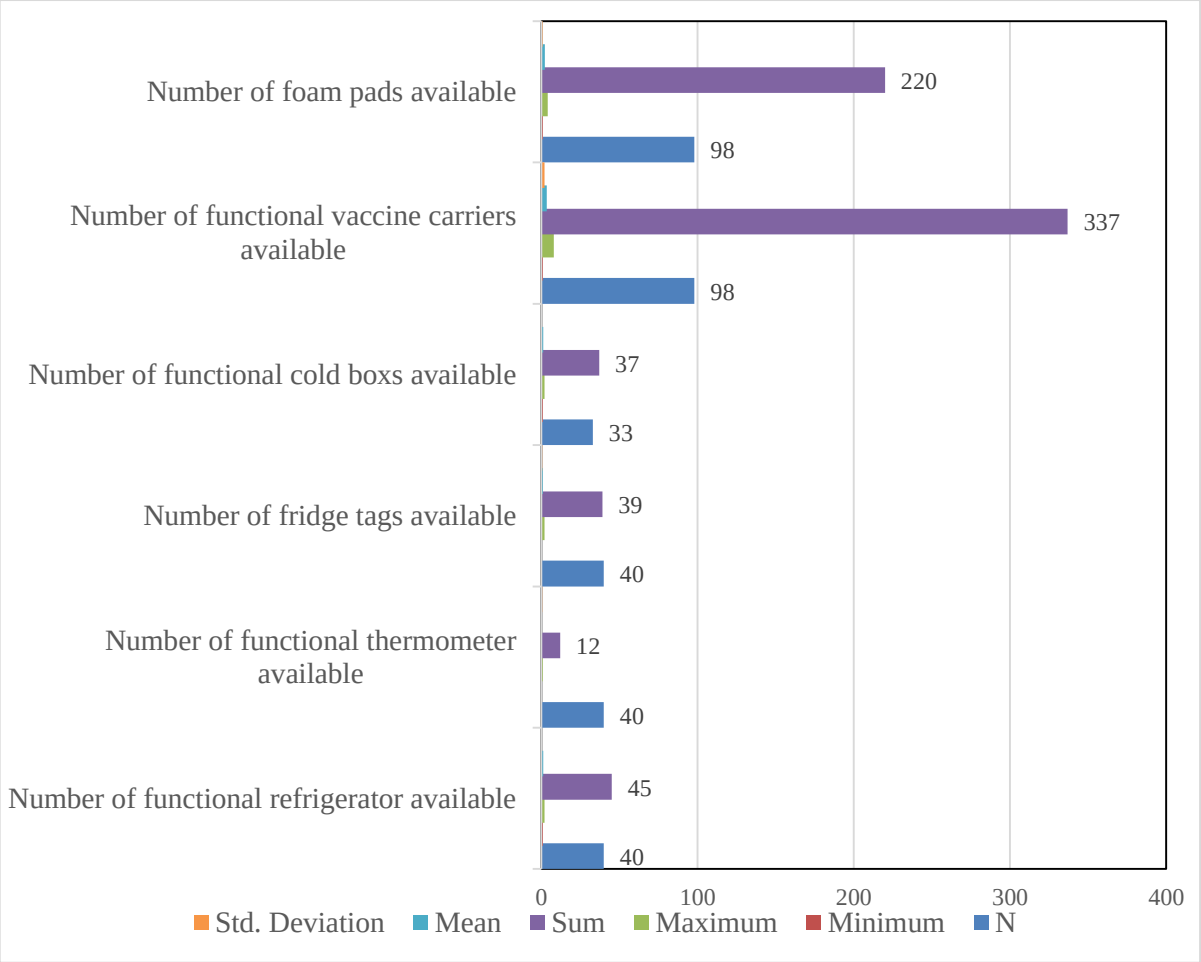

Figure 4: Cold chain equipment related characteristics on vaccine cold chain management practice in selected public healthcare institutions of West Arsi zone, Oromia, Ethiopia, 2023

5.6. Vaccine Cold Chain Management Practice

Concerning vaccine cold chain management practice, of the total of PHCFs that had refrigerators for vaccine storage, 38(95%) stored vaccine, 31(81.6%) placed refrigerators in well-ventilated areas away from sunlight, while only 3(7.9%) placed the packed vaccines apart from each other and air well circulating between them. Twenty (52.6%) of them recorded vaccine temperature twice daily for the last two months, and in 36(94.7%) PHCFs, the temperature range was within the correct range at visit time. The icepacks were properly placed in the refrigerator in 17(44.7%) facilities. In 26(68.4%) PHCFs, all vaccines were properly arranged in their recommended compartments, and in 25(65.8%) vaccines were placed in the manner of FEFO and their VVM status. On the other hand, four of them stored other items or non-vaccine drugs in the vaccine refrigerator, while two of them put expired vaccines in the refrigerator. Most health facilities, 80(81.6%), used foam pads during immunisation sessions, while less than half, 46(46.9%) used the regular request format for ordering and receiving vaccines.

Out of PHCFs that have refrigerators for vaccine storage, one health centre did not store the vaccine because of a temporary power line breakage. In the same way, one health post had not stored vaccines, even if a functional refrigerator was present. Of the total 98 facilities that participated in the study, 53(54.1%) had good vaccine cold chain management practices at 95% CI (40.9 - 70.1). Among the two hospitals, one demonstrated good practice. Of the total 29 health centres and 68 health posts, 17(58.6%) and 35(53.2%) had good vaccine cold chain management practice respectively **(Table 4).**

Table: 4 Status of vaccine cold chain management practice in selected public healthcare institutions of West Arsi zone Oromia, Ethiopia 2023 (N=98).

Variables	Responses	Frequency	Percent
Does the health facility store vaccine?(n=40)	Yes	38	95.0
	No	2	5.0
Refrigerator placed in well-ventilated area and away from sunlight(n=38)	Yes	31	81.6
	No	7	18.4
Vaccines correctly packed and air well circulating b/n them(n=38)	Yes	3	7.9
	No	35	92.1
Temperature recorded twice daily including weekend and holyday for last two months(n=38)	Yes	20	52.6
	No	18	47.4
Temperature range within a correct range 2 o/c to 8 o/c at visit time(n=38)	Yes	36	94.7
	No	2	5.3
Temperature outside of recommended range has been documented with actions taken(n=38)	Yes	2	5.3
	No	36	94.7
Icepacks properly placed in refrigerator(n=38)	Yes	17	44.7
	No	21	55.3
All vaccines properly arranged in their recommended compartments(n=38)	Yes	26	68.4
	No	12	31.6
Vaccines placed in the manner of FEFO and their VVM status(n=38)	Yes	25	65.8
	No	13	34.2
Vaccine placed in their original packing box with their leaflet(n=38)	Yes	23	60.5
	No	15	39.5
Vaccine diluents properly placed in correct compartment(n=38)	Yes	34	89.5
	No	4	10.5
Other items or non-vaccine drugs stored in vaccine refrigerator(n=38)	Yes	4	10.5
	No	34	89.5
Item type stored in vaccine refrigerator(n=4)	Water	2	50.0
	Obstetric medications	1	25
	Food	1	25
Expired vaccines stored in refrigerator(n=38)	Yes	2	5.3
	No	36	94.7
Foam pad used during immunization sessions(n=98)	Yes	80	81.6
	No	18	18.4
Regular request format used for ordering and receiving vaccine(n=98)	Yes	46	46.9
	No	52	53.1

***Table: 4** continued next…*

Level of vaccine cold chain management practice(n=98)	Poor vaccine cold chain practice	45	45.9
	Good vaccine cold chain practice	53	54.1

5.7. Factors associated with vaccine cold chain management practice

A bivariate logistic regression was performed to identify the association of predictor variables with vaccine cold chain management practices. Results of bivariate logistic regression analysis showed that marital status, residence, work experience, presence of supportive supervision, EPI guidelines, functional vaccine carries, presence of workload that may affect VCCMP, use of standard vaccine request format, and knowledge of vaccine handlers were significantly associated with vaccine cold chain management practice at a P-value <0.25. Among the candidate variables entered into multivariable logistic regression, five variables; presence of regular supervision, availability of EPI guidelines, workload, use of vaccine request format, and knowledge of vaccine handlers were significantly associated with the practice of vaccine cold chain management at a p-value of less than or equal to 0.05.

Multivariate analysis indicated that health care facilities that had regular supportive supervision were 4.81 times more likely to have good cold chain management practice compared to those without supportive supervision, AOR (95% CI) = 4.81(1.60–14.4). The facilities for which EPI guidelines were available were 5.21 times more likely to have good vaccine cold chain practice than those that did not, AOR (95% CI) = 5.21(1.67–16.3). Vaccine handlers who reported that the status of workload had no effect on vaccine cold chain management practice were 3.2 times more likely to show good practice than their counterparts, AOR (95% CI) = 3.20(1.06–9.71). Health care facilities that used the vaccine request format were almost 3.67 times more likely to practice vaccine cold chain management compared to facilities that did not use the vaccine request format, AOR (95% CI) = 3.67(1.21–11.10). The odds of having good vaccine cold chain management practices among vaccine handlers who had good knowledge were almost 3.85 times higher than those vaccine handlers who had poor knowledge, AOR (95% CI) = 3.85 (1.32-11.25). **(Table 5).**

Table:5 Multivariate analysis of associated factors on vaccine cold chain management practice in selected public healthcare institutions of West Arsi zone Oromia, Ethiopia 2023 (N=98).

Variables	Category	Level of vaccine CCMP		COR(95% CI)	AOR(95% CI)
		Good	Poor		
Regular supervision	Yes	34(64.2%)	13(28.9%)	4.40(1.87-10.35)	**4.81(1.60-14.4)****
	No	19(35.8%)	32(71.1%)	1	1
Guideline availability	Yes	46(86.8%)	19(42.2%)	8.99(3.33-24.22)	**5.21(1.67-16.3)****
	No	7(13.2)	26(57.8%)	1	1
Marital status	Unmarried	13(24.5%)	19(42.2%)	1	1
	Married	40(75.5%)	26(57.8%)	0.44(0.19-1.05)	0.88(0.26-2.95)
Workload	Yes	26(49.1%)	32(71.1%)	1	1
	No	27(50.9%)	13(28.9%)	2.55(1.10-5.92)	**3.20(1.06-9.71)***
Residence	Rural	28(52.8)	31(68.9%)	1	1
	Urban	25(47.2%)	14(31.1%)	1.98(0.86-4.53)	1.75(0.57-5.45)
Request format used	Yes	32(60.4%)	14(31.1%)	3.37(1.46-7.79)	**3.67(1.21-11.10)***
	No	21(39.6%)	31(68.9%)	1	1
Work experience	<2 years	5(9.4%)	8(17.8%)		1
	>=2 years	48(90.6%)	37(82.2%)	2.07(0.63-6.87)	4.38(0.69-27.34)
Knowledge of vaccine CCMP	Good	40(75.5%)	17(37.8%)	5.06(2.12-12.08)	**3.85(1.32-11.25)***
	Poor	13(25.5%)	28(62.2%)	1	1

*Abbreviations; AOR = Adjusted Odds Ratio, CI = Confidence Interval, COR = Crude Odds Ratio, * p < 0.05, ** p < 0.01 (statistically significant). 1 = reference group, Hosmer Lemeshow's test is 0.913, Method of regression, Backward LR, Multi-collinearity's, (VIF Min=1.046, Max=1.222)*

6. DISCUSSION

This study identified the level of vaccine cold chain management practice and its associated factors in public healthcare facilities in the west Arsi Zone and revealed that 54.1% of public health facilities had a good cold chain management practice. This finding was consistent with studies conducted in East Gojjam(58.3%) and Central Ethiopia(57.9%), but lower than the findings in the state of Ogboghodo(73.9%), Wolaita(61%) and Oromia Bale zone(62.8%)(Rogie, Berhane and Bisrat, 2013; Ogboghodo *et al.*, 2017; Bale *et al.*, 2018; Bogale, Amhare and Bogale, 2019; Offices *et al.*, 2023). On the other hand, this finding was higher than the reports from Southern Ethiopia, Guraghe Zone, Ezha(22.8%), Tigrayi(46%), Cameroon(24%) and India (Yauba *et al.*, 2018; Yassin *et al.*, 2019; Gebretnsae *et al.*, 2022; Haldar, Majumdar and Ghosh, 2022). The discrepancy might be due to profession-related characteristics, study settings and types of healthcare facilities, differences in sample size, and the availability of equipment used for vaccine cold chain management practice.

In this study, 20(52.6%) of PHCFs recorded vaccine temperature twice daily, which was nearly consistent with the study conducted in East Gojam 58.3%. This result was lower compared to the findings of the study carried out in Bahir Dar city, which was 71.4% and in West Bengal, India, the temperature was recorded twice daily, including on Sundays and holidays, but it was higher than the result from Tigray indicated only 23.5% and in Bale Zone, 42.8% of PHCFs correctly recorded daily temperatures(Mulatu, Tesfa and Dinku, 2020a; Gebretnsae *et al.*, 2022; Haldar, Majumdar and Ghosh, 2022). The reasons for the discrepancy may be the availability of temperature monitoring and recording tools, the vaccine handler's commitment, the status of supervision, and feedback towards cold chain management.

The findings of this study also indicated that 26(68.4%) of PHCFs were properly arranged the vaccines in their recommended compartments. In 25(65.8%) of PHCFs, the vaccines were placed in the manner of FEFO and their VVM status, which was similar to the study conducted in Nigeria in Osun State 63.6%. The result was higher compared to the findings of East Gojam and Bale Zone, which revealed that 43.8% and 40% of health facilities followed the FEFO principle to store vaccines, respectively.(Woldemichael, Bekele and Esmael, 2018; Bogale, Amhare and Bogale, 2019; Adebimpe and Adeoye, 2021b). The possible reason for this difference may be due to the difference in knowledge level and commitment of vaccine handlers, supervision, and a shortage of cold chain equipment.

This study revealed that 58.2% of vaccine handlers had good knowledge of vaccine cold chain management practice, which was consistent with studies from the Gurage zone, Bale zone, and central Ethiopia(Rogie, Berhane and Bisrat, 2013; Woldemichael, Bekele and Esmael, 2018; Yassin *et al.*, 2019) which revealed (53.5%), (54.6%) and (56%) respectively. However, our finding was lower when compared with another study conducted in Wolaita southern Ethiopia(78.7%) and Malaysia (78%)(N and Mohd Noor, 2014; Offices *et al.*, 2023) On the other hand, this result was higher than the findings from the Gojjam zone of Ethiopia and Nigeria states (38.3%, 36% and 43%,)(David M Dairo and Osizimete, 2016b; Bogale, Amhare and Bogale, 2019; Adebimpe and Adeoye, 2021b)respectively. The discrepancy may be due to a difference in operational definition, study settings, training on EPI, profession type, and work experiences of the study participants.

In this study, the types of vaccines that were most sensitive to heat and freezing were correctly reported by 57.1% and 16%, respectively. The recommended temperature range for most vaccines in refrigerators and the recommended temperature recording frequency were correctly reported by 91.8% and 84.7%, respectively. This finding is almost the same as a report from northern Ethiopia(Mulatu, Tesfa and Dinku, 2020a) that almost all respondents correctly answered the recommended temperature range for most vaccines, while a study in southern Ethiopia (Yassin *et al.*, 2019) showed 83.6% of respondents knew the correct frequency of the refrigerator's temperature to be recorded. However, the knowledge of the respondents on the recommended temperature range was slightly higher than the results of the Gurage Zone and Bale Zone, which revealed 71.1% and 67.8%, respectively(Woldemichael, Bekele and Esmael, 2018; Feyisa *et al.*, 2022). This discrepancy may be due to the difference in knowledge level towards the asked question and the profession type of the study participants.

Additionally, this finding showed that indications of VVM, shake test, and FEFO principle were correctly reported by 65.3%, 62.2%, and 50%, respectively. This finding was lower when compared with another study conducted in West Bengal, India(Haldar, Majumdar and Ghosh, 2022), revealed that nearly all cold chain handlers were knowledgeable about VVM, the temperature range of ILRs and DFs, the shake test, the open vial policy, and freeze- and heat-sensitive vaccines. In the same way, findings from a study done in northern Ethiopia(Mulatu, Tesfa and Dinku, 2020a) revealed almost all respondents knew about VVM, while 85.7% correctly reported an indication of a shake test. The possible reason for

this difference may be due to the difference in knowledge level towards the asked question and the professional type of the study participants.

This study further showed that the knowledge of the respondents on shake tests and VVM was slightly higher than the study conducted in the Nigerian state of Osun.(Adebimpe and Adeoye, 2021b), that revealed 54% and 19%, Oromia Bale zone 36.2% for both(Woldemichael, Bekele and Esmael, 2018). Similarly, a study conducted in Tigray showed 12% of the respondents knew about the shake test, while 52% knew the principle of FEFO. This finding is almost the same as a report from Northern Ethiopia, Tigray, and East Gojam that shows 64% and 58% of respondents knew the proper interpretation of VVM, respectively.(Bogale, Amhare and Bogale, 2019; Gebretnsae *et al.*, 2022) The possible reason for a lower or higher difference might be the difference in knowledge level towards the asked question and the profession type of the study participants.

In this study, the presence of supportive supervision in the facility had a positive association (AOR (95% CI) = 4.81 (1.60–14.4) with good cold chain management practices. This study was similar to the study conducted in Nigeria, Oyo State, and Tigray, northern Ethiopia.(David M. Dairo and Osizimete, 2016; Gebretnsae *et al.*, 2022) found that vaccine handlers who had gotten supportive supervision in the previous six months were 4.58 times more likely to have effective cold chain and vaccine management practices than those who hadn't. In the same way, the results of the study done in Wolaita Zone, in the southern part of Ethiopia(Offices *et al.*, 2023) revealed that health care facilities with supportive supervision were 2.71 times more likely to have good cold chain management when compared to facilities without supportive supervision. The possible explanation for this finding could be associated with the benefits that health workers gain from updated information and support from their supervisors to fill their gaps regarding cold chain management practices and be motivated to work on given feedback early.

The odds of having an EPI guideline for good vaccine cold chain management practice were five times higher than their counterparts; the AOR (95% CI) was 5.21(1.67–16.3). This finding was consistent with the study conducted in Guraghe Ezha, Guji zones of Ethiopia, and Oyo State, Nigeria.(David M. Dairo and Osizimete, 2016; Yassin *et al.*, 2019; Degavi *et al.*, 2021). Possibly, the presence of guidelines in health care facilities will help vaccine handlers update themselves and fill their gaps in cold chain management practice.

Workload influences job satisfaction, emotional tiredness, and implicit nursing care rationing, all of which have an impact on the quality of nursing care delivered(Maghsoud *et al.*, 2022). But the current study oddly revealed that vaccine handlers who said the "presence of workloads doesn't affect the practice of vaccine cold chin management properly" were three times more likely to show good practice than their counterparts, AOR (95% CI) = 3.20(1.06–97.71). This may make a difference in the psychological preparedness of healthcare personnel to perform their job even in very stressful situations and to avoid negligence.

In the same way, the findings of this study indicated that public healthcare facilities that regularly use vaccine request formats were 3.67(CI = 1.21–11.10) times more likely to perform good vaccine cold chain practices than facilities that don't use vaccine request formats to order and receive vaccines. Vaccine recording and reporting forms, including vaccination cards, vaccine request forms, and vaccine stock ledger books, are required for facilities providing routine immunisation to maintain an immunisation record as per the format recommended by the Ministry of Health. Regular use of the vaccine request format makes it easier to balance, monitor, and manage all types of vaccines, diluents, AD-syringes, mixing syringes, droppers, and other consumables like a safety box(Manual, 2015; Ababa, 2021).

6.1. Strengths and Limitations

6.1.1. Strength

The measure that can be mentioned as the strength of this study is the fact that it was employed in different public healthcare institutions that were representative of all. The data were collected using the WHO and UNICEF-effective vaccine management assessment tools through different data collection techniques, like self-administered questionnaires, observational checklists, and document reviews. Furthermore, it is less likely to be affected by bias as we did not inform the vaccine handlers ahead of the visit.

6.1.2. Limitation

As a limitation, this study doesn't include woreda and zonal vaccine stores and handlers. Additionally, the sample size of the study was relatively small, which may affect the statistical inferences of the modelling.

7. CONCLUSION AND RECOMMENTATION

7.1. Conclusion

The findings of this study indicated that the practice of vaccine cold chain management at public healthcare facilities in West Arsi Zone, Oromia, Ethiopia, was less than desired. The presence of supportive supervision and EPI guidelines in the facility, having good knowledge of vaccine cold chain management, workload, and using vaccine request formats were significant predictors of vaccine cold chain management practice.

7.2. Recommendation

Regional health bureau/zonal/woreda health office

Providing an EPI guideline for all health facilities and training vaccine handlers to increase their knowledge so as to improve their vaccine cold chain management practices is highly advisable. In addition, well-programmed supportive supervision is recommended to monitor, encourage, motivate, and improve the status of vaccine handlers towards vaccine cold chain management practice.

Health professionals

Vaccine handlers are recommended to constantly update themselves by reading up-to-date guidelines and following accordingly to maintain a safe and effective vaccine cold chain practice.

For Researcher

This study was quantitative only, so further qualitative mixed studies will be recommended to be conducted on vaccine cold chain management practices to enhance the comprehensiveness of the findings.

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ANNEX

ANEX 1: Participant's Information Sheet and Consent Form (English Version)

My name is Abdo Hajo I am studying masters' degree in paediatrics and child health at Hawassa College of health sciences. I am conducting this study on "vaccine cold chain management practice" which planned to examine the current practice on vaccine cold chain management and its associated factors after approved by Institute Review Board. If you agree to join the study, you will be required to answer all the questions that will be asked by the investigator. All your information will be treated confidential and will not be used for any other purpose other than this study. We do not expect that any harm will happen to you because of joining in this study. Taking part in this study is completely your choice. You can stop participating in this study at any time, even if you have already given your consent. Taking part in this study you will contribute towards alleviating the problem of poor vaccines storage and improper vaccines management. You are invited to the study because you are working in vaccine cold chain management and practice in selected health facilities. Your information and others participating in the study will collectively be used by decision makers in addressing this problem. You will receive the new information about this study upon completion.

Duration: It takes 15 - 20 Minutes. Procedure to be carried out**:** it is a self-administered questioner and observational checklist.

May I have your permission? Yes ……. No…… If yes continue

For comments/questions please contact Abdo Hajo (0972622772), principal investigator for the study.

Questionnaire ID No_____
Woreda: _____
Health Center: _____

Health Post: _____

Hospital: _____

Date _____/_____/_____

ANEX 2: Questionnaire (English Version)

Part I: Socio-demographic and professional related characteristics

S.No	Questions	Responses	Skip to
101	Age	_____	
102	Sex	1. Male 2. Female	
103	Marital status	1. Single 2. Married 3. Other:_____	
104	Residence	1. Urban 2. Rural	
105	Level of education	1. Certificate/level III 2. Diploma/level IV 3. Degree and above	
106	Profession of respondent	1. Nurse 2. HEW 3. Pharmacy 4. Midwifery Other: _____	
107	Work experiences	1. _____Years	
108	Training	1. Yes 2. No	If yes
109	Type of training	1. On job training 2. Out of job training	

Part II: Institution related questions

S.No	Questions	Responses	Skip to
201	What is a main source of power for refrigerator?	1. Electricity 2. Generator/kerosene 3. Solar	
202	Is there car/motorbike in the facilities to use in case of refrigerator failure?	1. Yes 2. No	
203	Is there permanently assigned personnel for cold chain management?	1. Yes 2. No	
204	Is a personnel assigned during holidays/weekend for cold chain follow up?	1. Yes 2. No	
205	Is there national guidelines on immunization?	1. Yes 2. No	
206	Is there temperature recording chart?	1. Yes 2. No	
207	Is there standard vaccine requisition format?	1. Yes 2. No	
208	Is there regular supportive supervision of district health office?	1. Yes 2. No	
209	Do they give feedback of supervision	1. Yes 2. No	

Part III: Availability of cold chain equipments

S.No	Questions	Responses	Skip to
301	Does your facilities have refrigerator for vaccine storage?	1. Yes 2. No	
302	Number of refrigerator available	Functional ___Non function_____	
303	Does your facilities have cold box?	1. Yes 2. No	
304	Number of cold boxes available	Functional___ Non functional ____	
305	Does your facilities have vaccine carriers?	1. Yes 2. No Functional____ Non Functional ____	
306	Does your facilities have foam pads?	1. Yes 2. No 3. No _____	
307	Does your facilities have Icepacks?	1. Yes 2. No 3. No _____	
308	Is there functional thermometer?	1. Yes 2. No 3. No _____	
309	Is there fridge tags?	1. Yes 2. No 3. No _____	

Part IV: Knowledge of vaccine handlers on vaccine cold chain.

S.No	Questions	Responses	Skip to
401	What is the recommended temperature range for most vaccine stored in refrigerators?	1. -5 °C to +5°C 3. +4 °C to +10 °C 2. +2 °C to +8 °C 4.+8 °C to +15 °C	
402	What is the recommended temperature range for most vaccine stored in freezers?	1. +2 °C to -4 °C 3.-15 °C to -25 °C 2. -4 °C to -15 °C 4. Do not know	
403	How many times should the temperature of the refrigerator monitored and recorded?	1. Daily 3. Once a week 2. Twice daily 4. Twice a week	
404	Which of these vaccines is the most heat sensitive?	1. OPV 3. BCG 2. Pentavalent 4. TT	
405	Which of these vaccines is most freezing sensitive?	1. Pentavalent 3. TT 2.BCG 4.HBV	

406	Vaccine vial monitor indicated for?	1. Vaccines damage by heat 2.Vaccines damage by freeze	
407	Shake test is indicated for?	1. Heat sensitive vaccines 2. Freeze sensitive vaccines	
408	FEFO principle is applicable for which vaccine types?	1. Heat sensitive vaccines 2. Freeze sensitive vaccines 3. Vaccine diluents 4. Other (specify _____)	
409	What are the recommended vaccines in the vaccine carrier a cool life with cool water-packs during outreach unit.?	1. 3 to 18 hours 3. 5 to 10 hours 2. 1 to 2 hours 4. I don' t know	
410	What are the recommended vaccines in the closed cold box can maintain temperatures below +10 °C with frozen ice packs in the cold box a maximum cold life days when tested at a constant +43°C.?	1. 2 to 7 days 3. 1 to 2 days 2. 1 to 4 days 4. I don' t know	

Part V: Regarding staff workload/ insufficiency

S.No	Questions	Responses	Remark
501	Is the staff loaded with work?	1. Yes 2. No	
502	Do you think the workload affect you to practice vaccine CCM properly?	1. Yes 2. No	
503	Do you think staff shortage affects performing CCM practice properly?	1. Yes 2. No	

Part VI: Vaccine cold chain management practice observational checklist

S.No	Questions	Responses	Skip to
601	Is a refrigerators is situated in a well-ventilated area, away from sunlight and heat	1. Yes 2. No	
602	Is a refrigerators is correctly packed with air circulating between the vaccines	1. Yes 2. No	
603	Is the refrigerator's temperature is within correct range of 2ºC to 8ºC at the time of visit?	1. Yes 2. No 3. Specify _____	
604	Is a temperature of the vaccine refrigerator has been recorded twice a day including weekend and holyday for last two months?	1. Yes 2. No 3. Specify _____	
605	Is there responses to all deviations outside +2°C and +8°C has been documented with actions taken?	1. Yes 2. No 3. Specify _____	
606	Is an Icepacks properly packed inside the refrigerators?	1. Yes 2. No	
607	Is a vaccines properly arranged inside the refrigerators with recommended compartments?	1. Yes 2. No 3. Specify _____	
608	Is a vaccines are correctly stored in the manner of first expiry first out or according to their VVM status?	1. Yes 2. No 3. Specify _____	
609	Is the vaccines are in their original packaging box and include the information leaflet?	1. Yes 2. No 3. Specify _____	
610	Is the vaccine diluents properly placed inside the refrigerators?	1. Yes 2. No	

611	Does a foam pad were used during immunization sessions?	1. Yes 2. No	
612	Is there other items in vaccine refrigerator such as other drugs, food, water…?	1. Yes 2. No 3. Specify _____	
613	Is there expired vaccines in refrigerator?	1. Yes 2. No 3. Specify _____	
614	Does regular requisition forms used for ordering and receiving vaccine?	1. Yes 2. No 3. Specify _____	

Thank you!!!

ANEX 3: Participant's Information Sheet and Consent Form (Afaan Oromoo Version)

Waraqaa odeeffannoo hirmaattotaaf kennu

Ani maqaan koo Abdoo Haajoo yoo ta'u, yuuniversiitii Hawasaatti barataa digirii lammaffaa muummee ''pediatrics and Child health Nursing'' ti. Qorannoo kana kan adeemsifnuuf haala ammaa qabiinsi qorichoota talaallii dhibee daa'immaniitiif oolan (vaccines) fi sababoota gufuu ta'uu danda'an addaan baasuuf yoo ta'u qorannoo kana gaggeessuuf yuuniversiitii Hawaasaatti qaama dhimmi ilaalu (IRB) irraa beekkamtiin nuuf kennameera.

Qorannicha keessatti ni hirmaattu yoo ta'e gaafilee hundaafuu deebii kennuun akkaan barbaachisadha. Yaadonni isin kennitan hundinuu qaama biraatiif dabarfamee kan hin kennamnefi qorannoo kana qofaaf malee dhimma biraatiif kan oolu miti. Qorannoo kanatti waan hirmaattaniif ykn hirmaachuu dhiistaniif rakkinni isin muudatu tokkoyyuu hin jiraatu. Qoranichatti hirmaachuun fedhii keessan kan gaafatuufi eegaltaniis addaan kutuu kan dandeettan ta'ullee qorannichatti hirmaachuun keessan rakkinoota qabiinsaa fi itti fayyadamiinsa dawaa talaallii dhukkubootaatiif tajaajilaniin wal qabatee jiru hambisuuf qooda guddaa qabaata. Qoranichatti akka hirmaattan kan barbaadameef dhimmichi caalatti gahee ogummaa keessaniitti waan dhihaatuufi. Yaanni isiniifi hirmaattonni biroo nuuf kennitan walitti qabamee bu'aa qorannoo irraa argameen qaamonni dhimmi ilaalu furmaata akka itti kennaniif kan oolu ta'a. Waa'ee bu'aa qorannoo dhuma qorannoo irratti kan dhageettan ta'a.

Sa'aatii itti fudhatu: 15 – 20 minutes

Haala ragaan ittiin guutamu: 1. Ofiin dibbisanii guutuu 2. Ilaalaa guutuu

Qorannicha itti fufuuf fedhii qabduu? 1. Eyyee 2. Miti

Yaadaa fi gaafii yoo qabaattan maaloo qorataa qorannoo kanaa qunnamaa (0972622772)

Lakk Galmee_____

Maqaa Aanaa : _____

Maqaa BF/KF/Hosp:_____

Guyyaa: _____

ANEX 4: Questionnaire (Afaan Oromo Version)

Part I: Gaafilee haala hawaas-diimogiraafii fi Ogummaan wal qabatan

S.No	Gaafilee	Filannoolee deebiif dhiyaatan	Ka itti aanutti
101	Umurii	1. _____	
102	Saala	1. Dhiira 2. Dubara	
103	Haala gaa'elee	1. Hin fuune/heerumne 2. Fuudhe/ heerumte 3. Kan biraa:_____	
104	Bakka jireenyaa	1. Magaalaa 2. Baadiyaa	
105	Gosa ogummaa	1. Narsii 2. Ekistenshiinii fayyaa 3. Ogeessa faarmaasii 4. Nursii deessiftuu 5. Other: _____	
106	Sadarkaa barnootaa	1. Sartifikeetii/level III 2. Dipiloomaa/level IV 3. Digirii	
107	Muuxannoo hojii	Waggaa _____fi ji'a _____	
108	Leenjii fudhattee beektaa?	1. Eyyee 2. Miti	Eyye gara
109	Gosa leenjii	1. Leenjii hojii irraa 2. Leenjii hojiin alaa	

Part II: Gaafilee haala dhaabbilee fayyaa ilaalan.

S.No	Gaafilee	Filannoolee deebiif dhiyaatan	Ka itti aanutti
201	Maddi anniisaa firiigiif oolu maal inni?	1. Elektirikii 2. Gaazii/ keeroosiinii 3. Soolaarii	
202	Konkolaataan/ motor-saayikiliin jiraa?	1. Eyyee 2. Hin jiru	
203	Ogeessi dhaabbataan too'annoo dawaalee talaalliif ramadame jiraa?	1. Eyyee 2. Hin jiru	
204	Guyyota ayyaanaa fi sambataatti ogeessi dawaa talaallii too'atu ramadamaa?	1. Eyyee 2. Hin jiru	
205	Qaleelfamni EPI jiraa?	1. Eyyee 2. Hin jiru	
206	Gucni/unki tempereechera irratti guutan jiraa?	2. Eyyee 3. Hin jiru	
207	Gucni/unki dawaa talallii ittiin gaafatan jiraa?	1. Eyyee 2. Hin jiru	
208	Hordoffii fi deeggarsa itti fufiinsaan aanaan ni taasiaa?	1. Eyyee 2. Hin taasisu	
209	Hordoffii booda duub-deebii ni laatuu?	1. Eyyee 2. Hin kennamu	

Part III: Gaafilee dhiyeessii meshaaleetiin wal qabatan gaafachuuf qophaaye.

S.No	Gaafilee	Filannoolee deebiif dhiyaatan	Ka itti aanutti
301	Firiijiin dawaa talaallii kuusuuf oolu jiraa?	2. Eyyee 2. Hin jiru 3. Meeqa _____	
302	Freezeriin dawaa talaallii kuusuuf oolu jiraa? Meeqa?	1. Eyyee 2. Hin jiru Kan hojjatu ___kan hin hojjanne___	
303	Sanduuqni qorraa/cold box jiraa? Meeqa?	1. Eyyee 2. Hin jiru Kan hojjatu ___kan hin hojjanne___	
304	Vaccine carriers' jiraa? Meeqa?	1. Eyyee 2. Hin jiru Kan hojjatu ___kan hin hojjanne___	
305	Foam pads jiraa?	1. Eyyee 2. Hin jiru 3. Meeqa? _____	
306	Icepacks jiraa?	1. Eyyee 2. Hin jiru 3. Meeqa? _____	
307	Teermoomeetirri jiraa?	1. Eyyee 2. Hin jiru 3. Meeqa? _____	
308	Fridge tags jiraa?	1. Eyyee 2. Hin jiru 3. Meeqa? _____	

Part IV: Gaafilee beekumsa ogeessota talaallii too'atanii fi kennan gaafachuuf qophaa'e

S.No	Gaafilee	Filannoolee deebiif Dhiyaatan	Ka itti aanuttii
401	Hammi tempereechera dawaan talaallii baay'een firiijii keessatti akka kaayamuuf gorfamu meeqa?	1. -5 oc - +5 oc 3. +4 oc - +10 oc 2. +2 oc - +8 oc 4.+8 oc - +15 oc	
402	Hammi tempereechera dawaan talaallii baay'een Freezer keessatti akka kaayamuuf gorfamu meeqa?	1. +2 oc - -4 oc 3.-15 oc - -25 oc 2. -4 oc - -15 oc 4. Hin beeku	
403	Hammi tempereechera firiigii si'a meeqa too'atamuufi galmeeffamuu qaba?	1. Guyyaatti tokko 3. Torbetti 1 2. Guyyatti lama 4.Torbetti lama	
404	Talaalliin irra caalatti hoo'aan miidhamu isa kami?	1. OPV 3. BCG 2. Pentavalent 4. TT	
405	Talaalliin irra caalatti qorraan miidhamu isa kami?	1. Pentavalent 3. TT 2.BCG 4.HBV	
406	Vaccine vial monitor talaallii gosa kamiif gargaaramna?	1. Talaallii hoo'aan badaniif 2. Talaallii qorran badaniif	
407	Shake test talaallii gosa kamiif gargaaramna?	1. Talaallii hoo'aan badaniif 2. Talaallii qorran badaniif	
408	FEFO talaallii gosa kamiif gargaaramna?	1. Talaallii hoo'aan badaniif 2. Talaallii qorran badaniif 3. Dhangala'aa talaallii bulbuluuf gargaaruuf 4. Kan biraa (specify _____)	
409	Talaalliin vaccine carrier bishaan cabbiin marfame keessatti yeroo duula talaaliitti yeroo hammamiitiif akka tursiifamu gorfama?	1. Sa'aatii 3 to 18 3. Sa'aatii 5 to 10 2. Sa'aatii 1 to 2 s 4. Hin beeku	

410	Talaalliin sanduuqa qabbanaa bishaan cabbiin marfame keessatti yeroo hammamiitiif akka tursiifamu gorfama?	1. Guyyaa 2 to 7 2. Guyyaa 1 to 4 3. Guyyaa 1 to 2 4. Hin beeku	

Part V: Gaafilee ulfaatina hojii ogeessotaatiin wal qabatu

S.No	Gaafilee	Filannoolee deebiif dhiyaatan	Ka itti aanu
501	Hojiin humnaa ol baay'ataa?	1. Eyyee 2. Lakki	
502	Hojiin humnaa ol baayachuun hordoffiifi kunuunsa dawaa talaalliitiif godhamu ni hanqisaa?	1. Eyyee 2. Lakki	
503	Hammi ogeessaa gahaa ta'uu dhabuun hordoffiifi kunuunsa dawaa talaalliitiif godhamu ni hanqisaa?	1. Eyyee 2. Lakki	

Part VI: Gaafilee haala qabiinsaafi kunuunsa dawaalee talaalliitiif godhamu ilaaluuf qophaaye.

S.No	Gaafilee	Filannoolee deebiif dhiyaatan	Ka itti aanu
601	Firiijiin iddoo mijataa qilleensa gahaa qabuttiifi hoo'aa fi ifa aduu irraa bilisa ta'etti kaayameeraa?	1. Eyyee 2. Miti	
602	Firiijii keessatti dawaaleen talaallii akka qilleensa argatanitti wal irraa siikfamanii kaa'amaniiruu?	1. Eyyee 2. Miti	
603	Yeroo ilaalamutti tempereecherri firiijii 2ºC - 8ºC gidduu jiraa?	1. Eyyee 2. Hin jiru Specify _____	
604	Tempereecherri firiijii ji'oota lamaan darbaniif guyyatti yeroo lama guyyaa ayyaanaatiifii sambata dabalatee galmeeffameeraa?	1. Eyyee 2. Lakki Ibsi: _____	
605	Tempereechera firiijii +2°C - +8°C ala baheef sirreeffamni fudhatame jiraa?	1. Eyyee 2.hin jiru Ibsi: _____	
606	Icepacks firiijii kessatti sirritti kaayameeraa?	1. Eyyee 2. Lakki Ibsi: _____	
607	Dawaaleen talaallii firiijii keessatti iddoo isaaniitti sirnaan kaayamaniiruu?	1. Eyyee 2. Miti Ibsi: _____	
608	Dawaaleen talaallii seera FEFO/VVM eeganii sirnaan kaayamaniiruu?	1. Eyyee 2. Miti Ibsi: _____	
609	Dawaaleen talaallii marti golgaa mataa isaaniitiin haguugamanii barreeffama ibsituu of keessaa ni qabuu?	1. Eyyee 2. Hin qaban Ibsi: _____	

610	Dhangala’aan dawaa bulbuluuf tajaajilu firiijii kessatti iddoo sirrii kaayameeraa?	1. Eyyee 2. Lakki	
611	Yeroo tajaajilli kitibaatii kennamutti ispoonjii/foam pad ni fayyadamuu?	1. Eyyee 2. Lakki	
612	Dawaalee talaalliitiin ala wontoonni biraa kanneen akka (nyaataa, bishaaniifi qorichoota biroo) firiijii kessatti kuufamanii jiruu?	1. Eyyee 2. Hin jiru Ibsi: _____	
613	Dawaan talaallii yeroon isaa irra darbe firiijii keessatti kan kuufame jiraa?	1. Eyyee 2. Hin jiru Ibsi: _____	
614	Gucni dhaabbataan dawaa talaallii ittiin gaafatamuufi fudhatamu ni jiraa?	1. Eyyee 2. Hin jiru Ibsi: _____	

Galatoomaa!!!