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Review Article

Relationship Between Knowledge, Attitude and Motivation of Officers in Managing the COVID-19 Vaccine Cold Chain: A Systematic Review

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ABSTRACT

Background: Vaccines are an important tool in preventing serious infectious diseases. Cold chain management is essential to maintain vaccine quality, including storage, transportation, and distribution at appropriate temperatures. This study aims to investigate the relationship between knowledge, attitudes, and motivation of health workers responsible for cold chain management of the COVID-19 vaccine.

Method: This was a systematic literature review study by searching through databases: Google Scholar, PubMed, Semantic Scholar, and Frontiers, using some keywords. 76 relevant previous studies were found. After filtering for publication year (post-2019), they reviewed 19 articles' abstracts. However, 10 articles lacked information on vaccine officers' knowledge, attitudes, and motivation in cold chain management. Thus, only 9 articles were included in the review.

Results: The results show that adequate knowledge, training, and understanding of guidelines significantly influence desired vaccine cold chain management practices. These studies also highlight the importance of understanding guidelines, efficient implementation, and sustainability aspects in vaccine management.

Conclusion: This research concludes that to increase the effectiveness of vaccination programs, efforts are needed to increase knowledge, training, and implementation of guidelines among health workers responsible for the vaccine cold chain. Efforts to understand and implement sustainable practices are also crucial. The conclusions from this research can help decision-makers improve vaccine cold chain management to ensure the success of the vaccination program.

Keywords: Vaccine; Cold Chain; Knowledge; Attitude; Motivation

INTRODUCTION

The vaccination program is an important step in efforts to prevent serious infectious diseases such as, measles, mumps, tetanus, polio, HPV, and others, and their spread throughout the world.[1] To ensure the success of this vaccination program, vaccine cold chain management is a key factor. This cold chain involves the process of storing, transporting and distributing vaccines at the right temperature,[2] so that the vaccine remains effective and safe to use. In practice, vaccine officers who are responsible for the vaccine cold chain are a key element in maintaining the quality of the vaccine.

Vaccine management is part of vaccine quality which can prevent irregularities in vaccine storage and distribution so that the vaccine's potency is maintained when it is used.[3] This study examined the knowledge, attitude, and motivation of healthcare workers responsible for vaccine cold chain management. It assessed their adherence to guidelines, their training status, and the influence of these factors on vaccine management practices in primary health facilities. This research is important for improving immunization programs by identifying areas where healthcare workers may need additional support or training. In addition, this research can be used as basic data for evaluating the implementation of the vaccine cold chain because it will be related to vaccine efficacy/effectiveness.

Vaccines possess specific characteristics and require a cold chain system from their production in factories to their use in healthcare facilities.[4] Deviations from established guidelines can result in vaccine damage, potentially reducing or even eliminating their effectiveness when administered to recipients, thus failing to provide immunity.[5] Monitoring the storage temperature of vaccines is crucial for quickly determining whether vaccines remain viable or if they have become vulnerable and prone to damage.[6] This research discusses the cold chain Covid-19 vaccine. Various tools such as thermometers, Vaccine Vial Monitors (VVMs), and Freeze-tags greatly assist healthcare workers in monitoring the storage and transportation temperatures of Covid-19 vaccines. The appropriate temperature for managing vaccines and other factors that can affect vaccine damage include not exceeding the expiration date, the quality of vaccine management, and the method of transporting vaccines from one location to another.[7] The cold chain is a procedure used to maintain vaccines at specific temperatures until they are administered or delivered to their intended recipients.[8]

Vaccine officers have a crucial role in maintaining the vaccine cold chain so that it remains effective and safe. Even though there are officers in charge of vaccines at each community health center, it is unfortunate that until now, they have never received special training regarding vaccine cold chain management. Previous research shows that vaccine officers must meet certain qualifications and competencies obtained through education and training that are recognized with competency certificates.[9] Although specific cold chain training has not been carried out by the Ministry of Health, socialization training via the Zoom application has been provided.[10] However, vaccine officers also need to actively seek additional training and carry out independent supervision of the vaccine cold chain to ensure that vaccination can run well and is safe for the community.[11]

In order to increase the effectiveness of vaccination programs, a deeper understanding of the relationship between knowledge, attitudes and motivation of vaccine workers is needed in

vaccine cold chain management. Therefore, this research will conduct a systematic review of existing literature to comprehensively investigate the relationship between these three factors. It is hoped that the results of this research will provide better insight into the factors that influence vaccine cold chain management and encourage more effective improvement measures in the implementation of vaccination programs.

METHOD

This research is a systematic literature review which aims to reveal the relationship between knowledge, attitudes and motivation of officers in managing the COVID-19 vaccine cold chain. This research method is based on a literature review process that explains, summarizes, and evaluates scientific articles that have been previously published on the topic. This process begins with determining the background and objectives of the research. Then, research questions were created to guide the literature search. Literature searches were carried out through various databases in as Google Scholar, PubMed, Semantic Scholar and Frontiers with predetermined keywords. The search results obtained were checked and grouped based on selection standards, and after eliminating duplicates, there were 5 journals that were relevant to the research topic. The articles found are then sorted based on research quality using predetermined inclusion and exclusion criteria. A total of 5 journal articles met the inclusion criteria and were used as material for analysis in this research.

During the systematic review process, this research followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) guidelines for search results and study selection.[12] The principle of systematic review is a research method that summarizes primary research results to present more comprehensive and balanced facts. In the entire process, the systematic review method provides a strong basis for exploring the relationship between knowledge, attitudes and motivation in managing the vaccine cold chain, by combining previously existing research results and presenting them systematically and objectively.

1. **Data Search Strategy**
   Data search strategies include the methods used to search for information relevant to the research topic. In this case, the data search strategy involved using various databases such as Google Scholar, PubMed, Semantic Scholar, and Frontiers with the keyword “Knowledge”; "Attitude"; "Motivation"; "Vaccine Officer"; and "Vaccine Cold Chain". The aim of the data search strategy is to identify sources of information that are relevant to the research topic.
2. **Resources**
   Information sources are places or media where data and information can be found. In this research, the main sources of information are various databases and scientific literature related to the research topic, namely scientific articles obtained from Google Scholar, PubMed, Semantic Scholar, and Frontiers. These information sources are used to collect data relevant to research.
3. **Eligibility Criteria**
   Eligibility criteria are criteria used to determine whether an information source or article can be included in research or not. In this case, eligibility criteria include aspects such as topic,

source, publication time period, language, and research design. Only information sources that meet these criteria will be included in the analysis

4. **Quality Assessment**
   Quality assessment is a process for evaluating the quality of information sources used in research. In this research, quality assessment was carried out by reading the abstract and full text manuscript to assess whether the information source had a clear methodology and was relevant to the research topic.
5. **Data Extraction**
   Data extraction is the process of retrieving relevant information from selected information sources. In this research, data extraction includes obtaining information related to the relationship between knowledge, attitudes and motivation of officers in the management of the COVID-19 vaccine cold chain. The extracted data will be used for further analysis in the research.
6. **Synthesis Data**
   Data synthesis is the stage where information from various sources is combined, analyzed and presented systematically. In this research, data synthesis includes the process of grouping articles based on inclusion and exclusion criteria as well as analysis of articles that meet these criteria. The following inclusion and exclusion criteria in this study are outlined in table 1 below:

Table 1. Inclusion and Exclusion Aspects of Literature in this Research

Aspects	Inclusion	Exclusion
Topic	Articles should focus on the topic of the relationship between knowledge, attitudes and motivation of officers in managing the COVID-19 vaccine cold chain.	Articles that are not related to the knowledge, attitudes and motivation of officers in managing the COVID-19 vaccine cold chain.
Source	Only scientific articles, empirical research, systematic reviews, or literature reviews published in scientific journals are accepted.	Articles published in unrecognized journals or sources that cannot be verified.
Time Period	Published between 2019-2023	Published before 2019
Language	Articles written in English or Indonesian that researchers can understand.	Articles written in a language that the researcher cannot understand, which is except Indonesian or English.
Research Design	Articles must have a clear methodology and be relevant to the research topic, such as empirical research, systematic reviews, or literature reviews.	Articles that do not have a clear methodology or are not relevant to the research topic.
Information	Articles must provide relevant information about the knowledge, attitudes and motivation of officers in the context of managing the COVID-19 vaccine cold chain.	Article portrays irrelevant information, articles did not contain one of the variables in this research (knowledge, attitude, or motivation)

After applying keywords, researchers obtained 76 relevant previous studies. After applying a publication year filter (after 2019), researchers found 57 articles published before 2019. Next, researchers read the abstracts of the remaining articles, namely 19 articles. However, of the 19 articles, there are 10 articles that do not contain information regarding the knowledge/attitude/motivation of vaccine officers in managing vaccine cold chains. Thus, of the 19 articles, 10 articles were excluded leaving 9 articles for review. As for the 9 articles, 5 articles were obtained from Google Scholar, 2 articles from PubMed, 1 article from Semantic

Scholar, and 1 article from Frontiers. Thus, in this research, only 9 journal articles were reviewed to describe the relationship between knowledge, attitudes and motivation of officers in managing the vaccine cold chain.

The nine literatures were obtained through the elimination stage as depicted in the Figure 1.

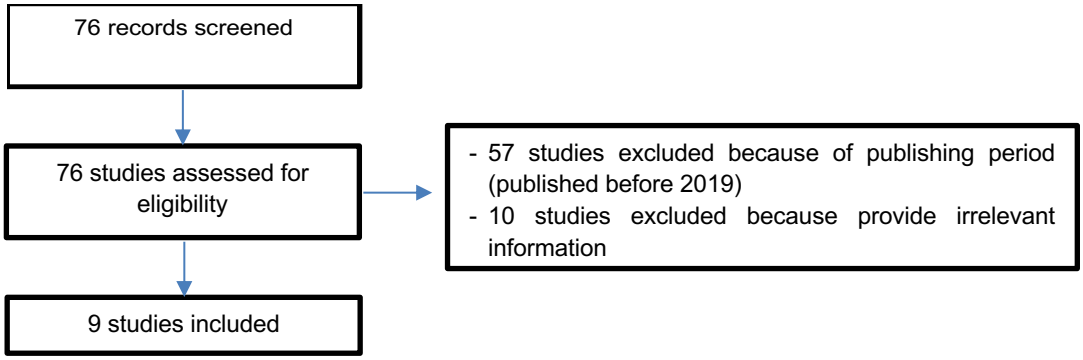

Figure 1. Data collection procedure

RESULTS

After searching on Google Scholar, PubMed, Semantic Scholar, and Frontiers using the keyword "Knowledge"; "Attitude"; "Motivation"; "Vaccine Officer"; and "Vaccine Cold Chain", Researchers found nine relevant articles. These nine articles also contained established inclusion criteria and did not have a single established exclusion criterion. The following is a summary of the literature reviewed in this research are outlined in Table 2.

Table 2. Summary of Literature Used in this Research

No	Research Title/Author/Year	Research Location	Research Aims	Methods	Population and sample	Result
1	Adherence to WHO vaccine storage codes and vaccine cold chain management practices at primary healthcare facilities in Dalocha District of Silt'e Zone, Ethiopia. Feyisa et al. (2022)	Dalocha District, Ethiopia	The aim of this study was to evaluate vaccine cold chain management in primary health facilities in Dalocha District, Silt'e Zone, Ethiopia. The research aims to measure the knowledge of vaccine cold chain officers, the level of compliance with WHO vaccine storage guidelines, and vaccine cold chain management practices. This study also aims to identify the relationship between primary	The research method used is institutional-based cross-sectional study. This study was conducted in twenty-eight primary health facilities located in Dalocha District, Silt'e Zone, SNNPR, Ethiopia. A total of one hundred and forty primary health workers were recruited as respondents from four health centers and twenty-four health posts operating in the Dalocha area. Data were collected through questionnaires	In this research, the sample used was 153 respondents. The population on which this sample calculation is based is the total number of primary health workers in primary health facilities, totaling 205 people. In the calculations, a single population proportion formula for cross-sectoral research is used, with a confidence	The research results show that the majority of respondents have adequate knowledge about storing vaccines in the temperature range recommended by WHO. Most respondents also record vaccine temperatures twice a day, maintain vaccine inventory records, and know the principle of First Expiry First Out (EEFO). However, most respondents did not understand

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			health workers' knowledge, officers' training status, primary health facilities' compliance with WHO vaccine storage guidelines, and the length of officers' work experience with vaccine cold chain management practices.	completed by respondents themselves and direct observation checklists adapted from WHO and WHO-UNICEF effective vaccine management assessment tools. The collected data was input using EPI version 3.1 software, then exported and analyzed using SPSS version 22. Statistical analysis was carried out to determine the level of knowledge, level of compliance with WHO cold chain management guidelines, and vaccine handling practices.	level of 95%. Based on these calculations, the initial sample required was 384. However, using a reduction formula, the final sample was determined to be 133 respondents. This is calculated by taking into account a limited target population of 205 people. Then, samples were taken using a stratified sampling method based on primary health facilities, and selected proportionally from each facility.	about vaccines that are susceptible to low temperatures, vaccines that are susceptible to high temperatures and light, and the use of Vaccine Vial Monitors (VVM). Primary healthcare facilities' compliance with WHO vaccine storage guidelines varies, with some facilities having poor practices, some with adequate practices, and a few with good practices. The results also showed that training, length of work experience, and knowledge of primary health workers were significantly related to desired vaccine cold chain management practices.
2	Knowledge of Health Professionals on Cold Chain Management and Associated Factors in Ezha District, Gurage Zone, Ethiopia. Yassin et al. (2019)	Ezha District, Gurage Zone, Ethiopia	Maintaining the quality of vaccines poses a significant challenge to immunization programs in Africa, including Ethiopia. This challenge is often attributed to the level of knowledge among health professionals regarding cold chain management. There is a scarcity of studies conducted in Ethiopia that directly investigate the knowledge of health professionals concerning cold chain management, prompting the need for this research.	A cross-sectional study was conducted within selected health facilities, involving all available health professionals, totaling 232 individuals. Data collection occurred through face-to-face interviews utilizing a semi-structured questionnaire during September to October 2016. An observational checklist was employed to assess the availability and functionality of refrigerators. Data were entered and cleaned using Epi Info software and subsequently analyzed using SPSS. A	The population in this study was all health professionals available at the selected health facilities, with a total of 232 individuals. Meanwhile, the sample in this study also consisted of all health professionals in the selected health facilities, totaling 232 individuals. So, the entire population is the sample in this study.	The response rate was 92.43%, and the study revealed that 119 (51.3%; 95% CI; 44.9%, 57.6%) health professionals possessed satisfactory knowledge about cold chain management. Several factors were found to be associated with improved knowledge in this area, including receiving training on the immunization program (AOR = 5.1; 95% CI: 2.68, 10.13), having more than six years of work experience (AOR = 2.1; 95% CI: 1.8, 4.15), using

No	Research Title/Author/Year	Research Location	Research Aims	Methods	Population and sample	Result
				multivariable logistic regression model was employed to identify factors associated with the knowledge of health professionals regarding cold chain management.		EPI guidelines (AOR = 2.58; 95% CI: 1.47, 5.57), and being a BSc nurse/health officer (AOR = 2.4; 95% CI: 1.47, 14.4).
3	Investigating sustainable development for the COVID-19 vaccine supply chain: a structural equation modelling approach. Mukherjee & Baral (2023)	India	Immunization is one of the most effective and cost-effective ways to save lives while promoting good health and happiness. The coronavirus disease 2019 (COVID-19) pandemic has served as a stark reminder of the ability of vaccines to prevent transmission, save lives, and create a healthier, safer, and more prosperous future. This research aims to investigate sustainable development (SD) in the COVID-19 vaccine supply chain (VSC)	This study investigates the relationship between internal processes, organizational growth, and its three SD pillars, namely environmental sustainability, economic sustainability, and social sustainability. Survey-based research was conducted at hospitals providing the COVID-19 vaccine. Nine hypotheses were proposed for this study, and all hypotheses were accepted. The survey was sent to 428 respondents and received 291 responses from health professionals for a response rate of 68%. For this study, healthcare professionals working in private and public hospitals across India were selected.	The total population in this study was 428 health professionals, while the research sample was 291 of these respondents.	A structural equation modeling (SEM) approach was used to test the hypotheses. These nine hypotheses all found support. This study explores the relationship between internal processes and organizational learning with the three pillars of sustainability (environmental sustainability, economic sustainability, and social sustainability).
4	The Relationship between Mother's Knowledge about Immunization and Mother's Compliance with Carrying Toddlers to Immunization in Hamlet V, Tanah Jawa District, Simalungun Regency. Manurung (2022)	Tanah Java Area, Indonesia	This study aims to evaluate the mother's level of knowledge, the level of compliance in bringing toddlers to get immunizations, and identify the relationship between the mother's level of knowledge and her level of compliance in bringing toddlers to get immunizations.	This research uses a descriptive correlational research design and applies total sampling in sampling. The number of respondents involved in this research was 40 people. The measurement instruments used were questionnaires and medical records	The population in this study were mothers with toddlers who met certain criteria in the Tanah Java area. The sample was taken as a whole (total sampling) involving 40 respondents who met the inclusion criteria.	The research results showed that 45% of respondents had insufficient knowledge and did not comply with the implementation of immunization at 88.9%. The results of the Chi-square test show that there is a statistically significant relationship

No	Research Title/Author/Year	Research Location	Research Aims	Methods	Population and sample	Result
				from community health centers in the Tanah Java area. The data analysis techniques used include the Chi-square test, as well as presenting data in the form of tables and diagrams.		between the mother's level of knowledge and her level of compliance in bringing her toddler to get immunization, with a p value of 0.004 < 0.05.
5	Description of Cakin Cold Chain Management System in Some Puskesmas Kecamatan in Jakarta Timur Region in 2019. Kusumadewi & Lestari (2020).	East Jakarta, Indonesia	This research aims to investigate the vaccine cold chain management system in several sub-district health centers in the East Jakarta area in July 2019.	The method used in this research is qualitative, with samples taken using a purposive sampling technique. Primary data was obtained through in-depth interviews, while secondary data was obtained from document review and observation of 2019 data. All officers involved in managing the vaccine cold chain have attended training at least once and have a higher education background.	The population in this study was 10 sub-district health centers in the East Jakarta area. The sampling technique used was the Non-Probability Sampling (Quota Sampling) method.	The research results show that in managing the vaccine cold chain, all community health centers have complied with the guidelines set out in the Vaccine Storage and Handling Toolkit (CDC 2014). The vaccine distribution process has been carried out well using cold boxes and cold packs. Apart from that, the vaccine is placed in a vaccine carrier which contains a cool pack and thermometer to ensure that the vaccine temperature is maintained properly.
6	Knowledge, Attitude, and Implementation of Cold Chain Management in Boalemo District, Gorontalo, Indonesia. Pangalo et al. (2020)	Gorontalo, Indonesia	The primary aim of this study is to investigate the relationship between three key factors: knowledge, attitude, and the implementation of cold chain management in the context of immunization programs aimed at improving children's health.	This research employed a cross-sectional design and was carried out in September 2018 across 11 health centers located in the Boalemo District of Gorontalo, Indonesia. Data collection was conducted through the utilization of questionnaires and observation sheets, and the subsequent data analysis was performed using the Chi-square statistical method.	The study sample consisted of 34 health officers, specifically selected for this purpose.	Elevated knowledge levels were associated with a higher likelihood of fostering a favorable attitude toward cold chain management implementation (OR= 5.87; p= 0.061). Additionally, increased knowledge (OR= 2.17; p= 0.448) and a positive attitude (OR= 2.69; p= 0.405) were linked to enhanced cold chain management implementation,

No	Research Title/Author/Year	Research Location	Research Aims	Methods	Population and sample	Result
						but these associations did not reach statistical significance.
7	Vaccine cold chain management practices in primary health centers providing an expanded immunization program in Northwest Ethiopia: self-reported and actual practice observational study. Ergetie et al. (2023)	Nortwest Ethiopia	The research aims to evaluate the practices related to the management of vaccine cold chains within primary health centers that provide the Expanded Program of Immunization (EPI) in Bahir Dar, Northwest Ethiopia. Specifically, it focuses on assessing how vaccines, crucial health commodities, are handled concerning their transportation, storage, and maintenance at the appropriate temperature levels to ensure their efficacy and safety.	A cross-sectional study involving self-reported data and direct observational practices was conducted at primary public health centers within the Bahir Dar city administration from August 15 to 30, 2021. Study participants were randomly selected using a simple random sampling method. Data collection involved the use of an interview-administered questionnaire and direct observation of actual practices. Subsequently, the collected data were entered into the Epidata 4.6 software and subjected to analysis using SPSS version 25. The study assessed participants' knowledge, storage and transportation conditions, Integrated Pharmaceutical Logistics System (IPLS) management, and practices related to vaccine cold chain management through independent samples t-tests and one-way ANOVA tests.	Sample 50 respondents, sampling technique use a random sampling.	The majority of EPI service providers exhibited a favorable level of knowledge (60%) and demonstrated proficient practices in vaccine storage and transportation (74%). Nevertheless, a significant proportion, comprising 68% of EPI service providers, exhibited inadequate proficiency in managing the Integrated Pharmaceutical Logistics System (IPLS). Furthermore, only half (50%) of the health centers demonstrated commendable actual practices in vaccine cold chain management. The study revealed that individuals with higher levels of education, lengthier work experience, and who had received training and supervision in EPI services, IPLS management, and vaccine inventory management exhibited higher levels of knowledge, proficiency in storage and transportation management, IPLS management, and vaccine cold chain

No	Research Title/Author/Year	Research Location	Research Aims	Methods	Population and sample	Result
						management practices.
8	Knowledge, attitude and practice of vaccinators and vaccine handlers on vaccine cold chain management in public health facilities, Ethiopia: Cross-sectional study. Mohammed et al. (2021)	Oromoia Special Zone, Ethiopia	The research aims to evaluate the knowledge, attitude, and practice of individuals responsible for vaccine handling and storage, specifically vaccinators and vaccine handlers, within public health facilities. It recognizes the critical importance of effective management of the vaccine cold chain system to preserve vaccine potency, particularly in light of vaccines' increased temperature sensitivity and complex immunization schedules. Therefore, this study seeks to assess the level of understanding, attitudes, and practices among these healthcare professionals in ensuring the proper handling and storage of vaccines within public health facilities.	The research employed an institutional-based cross-sectional study design to investigate the knowledge, attitude, and practice of 127 vaccinators and vaccine handlers within public health facilities in Oromia Special Zone. The data collection period spanned from September 1 to 30, 2019. To gather information, self-administered questionnaires and a structured observation checklist were utilized. The data were then subjected to both descriptive and inferential statistical analyses using the Statistical Package for the Social Sciences (SPSS) version 20.	the population in this research are all vaccinators and vaccine handlers who engaged in vaccine cold chain management. The sample in this research are 127 vaccinators and vaccine handlers within public health facilities in Oromia Special Zone.	The response rate for the study reached 96.94%. Among the participants, 68 individuals, constituting 53.5% (with a 95% confidence interval ranging from 46.5% to 61.4%), demonstrated satisfactory knowledge, while 58 individuals, equivalent to 45.7% (with a 95% confidence interval ranging from 37.8% to 53.5%), exhibited a positive attitude. Moreover, 62 participants, accounting for 48.8% (with a 95% confidence interval ranging from 41.7% to 56.7%), displayed good practice in their roles as vaccinators and vaccine handlers. It is worth noting that receiving training in cold chain management exhibited a statistically significant association with a higher level of knowledge concerning cold chain management (with an adjusted odds ratio of 3.04 and a 95% confidence interval between 1.04 and 8.88).
9	Knowledge of vaccine handlers and status of cold chain and vaccine management in primary health care facilities of Tigray region, Northern Ethiopia: Institutional based crosssectional	Tigray Region, Ethiopia	The primary aim of this study is to evaluate the knowledge of vaccine handlers and assess the status of cold chain and vaccine management within primary health care facilities located in	The research utilized an institutional-based cross-sectional study design and was carried out in four randomly chosen districts within the Tigray region of Northern Ethiopia. In each of the selected	The sample in this research are 50 healtcare professional	In this research, a total of fifty Primary Health Care Facilities (PHCFs) were included, resulting in a response rate of 94.4%. The overall proportion of vaccine handlers

No	Research Title/Author/Year	Research Location	Research Aims	Methods	Population and sample	Result
	study. Gebretnsae et al. (2022)		the Tigray region of Northern Ethiopia. This research is conducted to provide insight into the current state of cold chain and vaccine management practices, focusing on factors associated with these practices. The study aims to contribute valuable information to the efforts of the Ethiopia federal ministry of health in enhancing immunization services, particularly through the deployment of solar refrigerators, by addressing the existing knowledge gaps and challenges in cold chain and vaccine management in the specified region.	districts, all primary health care facilities equipped with functional vaccine refrigerators were included as participants in the study. Data collection was conducted using a pre-tested semi-structured questionnaire. The collected data were subsequently entered into Epi-data version 3.1 and later exported to Statistical Package for Social Sciences (SPSS) version 21 for the purpose of analysis. All variables demonstrating a p-value of < 0.25 in the bivariate logistic regression analysis were incorporated into the multi-variable model to identify predictors of the dependent variables under consideration.		with a high level of knowledge and a good status of cold chain and vaccine management stood at 48% (95% CI; 30.7%-62%) and 46% (95%CI; 26.1%-61.3%), respectively. It was observed that receiving training in cold chain and vaccine management (AOR = 5.18; 95% CI: 1.48–18.18) was significantly correlated with the knowledge of vaccine handlers. Additionally, the presence of supportive supervision (AOR = 4.58; 95% CI: 1.04–20.17) and a strong knowledge base among vaccine handlers (AOR = 10.97; 95% CI: 2.67–45.07) were found to be significantly associated with effective cold chain and vaccine management.

DISCUSSION

The discussion of this research will describe the relationship between knowledge, attitudes and motivation of officers in managing the vaccine cold chain based on the nine literatures reviewed.

1. **Knowledge of Vaccine Officer in Managing Vaccine Cold Chain**
   Several studies have assessed the knowledge of healthcare workers responsible for vaccine cold chain management. For instance, a study by Pangalo et al. conducted in Boalemo District, Gorontalo, Indonesia, aimed to investigate the relationship between knowledge, attitude, and the implementation of cold chain management in the context of immunization programs aimed at improving children's health. This cross-sectional study found that elevated knowledge levels were associated with a higher likelihood of fostering

a favorable attitude toward cold chain management implementation, although the associations did not reach statistical significance.[13]

A study conducted by Feyisa et al. assessed the knowledge of healthcare workers responsible for vaccine cold chain management. It examined their understanding of recommended temperature ranges, temperature recording practices, vaccine inventory management, and the EEFO (First Expiry First Out) method. While the majority of respondents demonstrated sufficient knowledge in these areas, some gaps were identified, particularly regarding vaccines sensitive to temperature extremes and the use of Vaccine Vial Monitors. The study also found that training, longer work experience, and a better grasp of guidelines were significantly associated with desirable vaccine cold chain management practices.[14]

Similarly, another study conducted in Northwest Ethiopia by Ergetie et al. evaluated the practices related to the management of vaccine cold chains within primary health centers providing the Expanded Program of Immunization (EPI). While this study did not explicitly mention the relationship between knowledge and attitude, it assessed the knowledge, storage, and transportation conditions of EPI service providers. Sixty percent of these providers demonstrated a favorable level of knowledge regarding vaccine cold chain management, indicating a substantial understanding of the subject.[15]

Additionally, Mohammed et al. conducted research in Oromia Special Zone, Ethiopia, focusing on vaccinators and vaccine handlers' knowledge, attitude, and practice regarding vaccine handling and storage. The study revealed that 53.5% of the participants demonstrated satisfactory knowledge of vaccine cold chain management. Furthermore, it found that receiving training in cold chain management was significantly associated with a higher level of knowledge.[16]

Lastly, the study conducted by Gebretnsae et al. in the Tigray Region of Ethiopia aimed to assess the knowledge of vaccine handlers in managing the vaccine cold chain. The primary objective was to understand the extent of knowledge among healthcare professionals responsible for handling vaccines and ensuring the cold chain's proper management within primary healthcare facilities. In this research, a total of fifty Primary Health Care Facilities (PHCFs) were included, resulting in a response rate of 94.4%. The findings revealed that approximately 48% of vaccine handlers exhibited a high level of knowledge concerning vaccine cold chain management. This knowledge encompassed various aspects related to vaccine storage, transportation, and maintenance within the recommended temperature ranges. The study emphasized the significant correlation between receiving training in cold chain and vaccine management and vaccine handlers' knowledge levels. This underscores the importance of ongoing training and education to enhance the proficiency of vaccine handlers in maintaining the efficacy and safety of vaccines by ensuring the proper management of the vaccine cold chain.[17]

A good level of knowledge among officers has a significant impact on their practice in vaccine cold chain management. A solid understanding of the importance of temperature and proper cold chain management can help prevent potentially dangerous practices, such as the use of expired vaccines, and ensure vaccine safety and efficacy.[18] The lack of

knowledge of cold chain management officers is due to the unavailability of government regulations regarding the cold chain system which results in ignorance that vaccine refrigerators must be kept at a distance of <15 cm from surrounding walls and protected from direct sunlight.[19] As a result, there is a lot of vaccine cold chain equipment that is not managed properly, resulting in a lot of vaccine damage, as happened in research conducted by Prasetyo.[20]

2. Attitude of Vaccine Officer in Managing Vaccine Cold Chain

The success or failure of vaccination programs depends significantly on the perspectives and outlooks of healthcare professionals who handle vaccines.[21] The success of vaccination relies on achieving high immunization coverage and effectively managing vaccine inventory, which encompasses the correct storage and handling of vaccines.[22] Delved into the attitudes of healthcare professionals involved in vaccine cold chain management. While the study reported a moderate level of knowledge regarding recommended temperature ranges, it emphasized that training in cold chain management could improve knowledge. The study suggested that the use of guidelines and the length of work experience were also factors influencing vaccine cold chain management practices. However, it acknowledged the cross-sectional nature of the study and its limited scope, which could impact the generalizability of the findings.[23]

3. Motivation of Vaccine Officer in Managing Vaccine Cold Chain

A study explored the motivation of officers in managing the COVID-19 vaccine cold chain, with a focus on sustainability in economic, environmental, and social aspects. The research highlighted the interplay between organizational learning, social and environmental sustainability, and internal processes in vaccine management. It found that knowledge acquisition through training and education improved the efficiency of vaccine administration processes. Furthermore, the study revealed that social and environmental sustainability goals could positively impact economic sustainability. Sustainable practices, such as effective resource management and waste control, were linked to cost savings in cold chain management.[24]

The findings in previous research underscored the influence of healthcare workers' attitudes on mothers' compliance with immunization. Negative attitudes, lack of friendliness, or inattention from health workers could deter mothers from participating in immunization programs. The study also emphasized the importance of efficient vaccine distribution, as poor distribution could lead to vaccine unavailability in target areas, hampering immunization coverage. Effective health promotion efforts and strong relationships between health workers and the community were identified as key factors. Lastly, the timing of immunization was noted as critical, as inappropriate timing could disrupt mothers' daily activities and affect compliance.[25]

4. The Relationship Between Knowledge, Attitude, and Motivation of Vaccine Officer in Managing Vaccine Cold Chain

Kusumadewi's study research on the relationship between knowledge, attitudes, and motivation of vaccine cold chain management officers in community health centers in East

Jakarta. The research revealed that these officers had a higher educational background and regularly underwent training related to the vaccine cold chain. It highlighted the significance of knowledge in maintaining proper vaccine storage and transportation practices. Additionally, the study assessed vaccine cold chain distribution practices, finding that health centers adhered to guidelines, used appropriate equipment, and monitored vaccine temperatures closely. These practices contributed to maintaining vaccine quality during distribution, underscoring the commitment to vaccine cold chain maintenance.[3]

The findings of Kusumadewi's research reflect a commitment to maintaining the vaccine cold chain so that vaccines remain effective and safe to use. The combination of the knowledge of trained personnel and a careful distribution process is an important factor in the success of an immunization program. This is also in line with previous research which shows that training of vaccine management officers influences accuracy in administering vaccines in health care settings. In conclusion, this study highlights the importance of good coordination, adequate knowledge, and strict distribution procedures in maintaining the vaccine cold chain. All of this aims to maintain the effectiveness of the immunization program and protect public health.

CONCLUSION

In conclusion, these studies collectively emphasize the importance of knowledge, attitudes, and motivation in effective vaccine cold chain management. Training, adherence to guidelines, proper distribution procedures, and good coordination are key elements for maintaining the vaccine cold chain and ensuring the success of immunization programs.

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