RESEARCH ARTICLE: Self-Perceived Competencies of Rural Health Nurses on Cold Chain Management of Vaccines in Sulu

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*ABSTRACT***.** This research evaluated the self-assessed competencies of Rural Health Unit (RHU) Nurses in Sulu regarding cold chain vaccine management for Fiscal Year 2025, focusing on temperature control, equipment handling, quality assurance, and risk mitigation. Using purposive sampling, 100 respondents were selected, and data were analyzed through weighted mean, standard deviation, t-test, One-way ANOVA, and Pearson's r. Results showed that most participants were females aged 30–39, with at least two years of experience, primarily serving under contractual terms. Overall, nurses demonstrated a high level of competence, especially in temperature control and quality assurance. Statistical analysis revealed significant differences in competency based on age, gender, length of service, and employment status, notably in quality assurance and risk management. Strong correlations among all four competency areas emphasized their interconnectedness, suggesting that enhancing one domain could positively impact others. These findings highlight the importance of inclusive, skill-focused training programs—particularly for contractual and less experienced nurses—and call for sustained professional development efforts across all employment categories. To strengthen vaccine cold chain practices, RHUs are encouraged to implement comprehensive and equitable training strategies that support consistent and effective vaccine handling at every level of healthcare delivery.
KEYWORDS: Self-Perceived, Competencies, Rural Health, Vaccine

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Introduction

Effective cold chain management is essential to preserving vaccine potency and ensuring safe immunization, especially in countries with widespread vaccination efforts. The global resurgence of vaccine-preventable diseases and the emergence of new health threats have underscored the urgency of maintaining a reliable cold chain system. Inadequate cold chain practices pose serious public health risks, lowering vaccine coverage and diminishing the effectiveness of immunization programs (Chavez et al., 2023a; Chavez et al., 2024a).

Vaccines must be stored and transported within recommended temperature ranges from production to administration. Organizations such as the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) stress the necessity of an uninterrupted cold chain to maintain vaccine efficacy. Exposure to incorrect temperatures can weaken vaccine potency, reducing immunity and increasing the risk of disease outbreaks. This issue is more acute in low-

resource areas, where healthcare infrastructure is underdeveloped and electricity is often unreliable (UNICEF, 2020; WHO & Ministry of Health and Family Welfare, India, 2022; Chavez et al., 2020).

Beyond healthcare outcomes, weak cold chain systems can erode public trust and hinder disease eradication goals. The urgency for efficient cold chain logistics is amplified by global initiatives like COVAX, aimed at equitable vaccine distribution. Addressing cold chain gaps requires investment in infrastructure, training, and technology—such as solar refrigeration, digital monitoring tools, and localized distribution methods (Chavez & Vicente, 2024; Inoferio et al., 2024).

A national assessment in India found key deficiencies in cold chain systems, including unreliable electricity, limited storage capacity, and insufficient real-time monitoring, all of which contributed to vaccine spoilage (WHO & Ministry of Health and Family Welfare, India, 2022). UNICEF further reported that approximately 25% of vaccines are compromised in low-resource areas due to poor temperature regulation (UNICEF, 2020).

In Sulu, nurses demonstrated self-determination in managing cold chains by actively responding to local challenges like power interruptions and transport issues. Their proactive monitoring, problem reporting, and solution-finding not only improved system resilience but also enhanced their confidence and accountability in maintaining vaccine quality (Chavez et al., 2024b; Chavez et al., 2023b; Murro et al., 2023; Leon et al., 2024; Chavez et al., 2024c).

Research Questions

This study aimed to determine the self-perceived competencies of nurses on cold chain management of vaccines.

Specifically, it aimed to answer the following questions:

1. What is the demographic profile of nurses in the Rural Health Unit in terms of
    1.1 Age;
    1.2 Gender;
    1.3 Length of Service; and
    1.4 Employment Status?
2. What is the competency levels of the nurses in Rural Health Units on cold chain management of vaccines in the areas of;
    2.1 Temperature control;
    2.2 Equipment Management;
    2.3 Quality Assurance; and
    2.4 Risk Management?
3. Is there a significant difference in the level of competencies of Rural Health Unit nurses on cold chain management of vaccines when data are categorized by;
    3.1 Age;
    3.2 Gender;
    3.3 Length of Service; and
    3.4 Employment Status?

Is there a significant correlation among subcategories subsumed under the level of competencies of nurses on cold chain management of vaccines?

Literature Review

Foreign Studies and Literature

Overview of Cold Chain Management. Cold chain management is a critical component in safeguarding the potency of vaccines by ensuring they are consistently stored, handled, and transported within specific temperature ranges, generally between 2°C and 8°C. Any interruption in this chain can lead to vaccine degradation. By evaluating the self-perceived competencies of nurses in Sulu, insights can be gained into potential knowledge gaps that may affect vaccine quality and delivery.

Equipment Management in Cold Chain Systems. A key aspect of cold chain operations is equipment management, which includes the proper selection, maintenance, and operation of devices such as refrigerators, cold boxes, insulated transport containers, and temperature monitoring tools. Reliable power backups and routine inspections are essential to prevent equipment failure and preserve vaccine quality throughout the supply system.

Quality Assurance in Vaccine Handling. Quality assurance (QA) in this context refers to structured processes designed to ensure consistent adherence to vaccine handling standards. These include monitoring temperatures, calibrating storage equipment, training healthcare staff, and conducting audits. QA serves to minimize risks that may compromise vaccine safety due to human or mechanical error (WHO, 2018; Suleman et al., 2020).

Risk Management in Cold Chain Logistics. Risk management in cold chain systems involves identifying possible threats, evaluating their potential impact, and implementing preventive measures. These include preparing for power outages, ensuring alternative transport arrangements, and regularly training staff on emergency protocols (Zaffran et al., 2018; Yang & Li, 2021).

Temperature Control Technologies. Maintaining the correct storage temperature is vital from the point of manufacture to administration. Technologies like solar-powered refrigerators and digital temperature loggers are particularly helpful in rural settings where consistent electricity supply is a challenge (PATH, 2022; UNICEF, 2020).

Role of Experience and Employment Status in Competency. Several studies support the role of experience and training in enhancing cold chain competencies. For instance, Kasahun et al. (2023) found that Ethiopian health workers with over five years of experience, especially permanent staff, displayed better knowledge of vaccine handling and equipment use. Gender disparities and limited access to training among female workers were noted as barriers to competency.

Regional Evidence from Africa on Protocol Adherence. Similar observations were made in West Africa, where experienced workers followed protocols more accurately, aided by familiarity with cold chain tools (Yugbaré et al., 2021). PATH (2022) and UNICEF (2020) emphasized the importance of stable employment and ongoing training in improving proficiency, especially when operating advanced cold chain equipment. Moreover, Mose et al. (2019) and Sokhna et al. (2021) both associated long service duration with better adherence to standards.

Importance of Competency-Based Training. Effective cold chain operations also depend on competency-based training. Studies by Dawson (2010), Haidari et al. (2017), and Wang et al. (2018) show that well-trained personnel significantly reduce the risk of vaccine spoilage. Likewise, Kalu and Eze (2020) found that those with greater cold chain knowledge consistently maintained correct temperatures.

Risk Management Skills and Emergency Preparedness. Lastly, multiple sources underscore the significance of risk management training. For example, Wang and Tang (2019), Mukherjee et al. (2020), and Joshi et al. (2019) noted that staff skilled in emergency response and risk assessment are better equipped to manage disruptions and protect vaccine quality.

Local Studies and Literature

Overview of the Study. The study by Ulep and Uy (2020) examines the Expanded Program on Immunization (EPI) in the Philippines, with a specific focus on the challenges related to cold chain management. While the EPI has made substantial progress in increasing vaccination coverage and improving public health outcomes, the research identifies significant challenges that hinder the effectiveness of the vaccine distribution system, particularly in ensuring proper vaccine handling through the cold chain process.

Cold Chain Management Challenges. One of the primary challenges discussed in the study is cold chain management, which ensures that vaccines are consistently stored and transported within the required temperature range (typically between 2°C and 8°C). The study identifies several knowledge gaps among healthcare workers, many of whom lack awareness of the correct procedures for vaccine storage and transportation. This lack of understanding leads to improper handling, potentially compromising the potency and effectiveness of vaccines, which can ultimately undermine the success of vaccination efforts (Garil, 2024; Carpio et al., 2024).

Infrastructure Limitations. Another significant issue identified in the study is infrastructure limitations, particularly in rural areas. Many healthcare facilities in these regions struggle with inadequate storage facilities, insufficient refrigeration equipment, and unreliable power sources. These challenges jeopardize the ability to maintain vaccines at the correct temperature, which is crucial for preserving their effectiveness. The study notes that remote regions are particularly affected, as they face additional logistical difficulties and inconsistent electricity supply, further exacerbating cold chain management problems (Murro, 2024; Bondoc, 2024).

Need for Improved Training Programs. The authors emphasize the critical need for improved training programs aimed at enhancing the knowledge and skills of healthcare workers. Proper training is essential for ensuring that frontline health personnel can manage the cold chain system effectively. The study recommends that training should be regular, updated, and reflective of the latest changes in cold chain technologies and best practices. Strengthening the competencies of healthcare workers will help prevent lapses in vaccine handling and storage, ensuring that vaccines remain effective throughout the distribution process (Garil et al., 2024; Bondoc Jr., 2024; Quisay & Aquino, 2024).

Infrastructure Upgrades and Technological Investment. The study calls for substantial investments in the infrastructure supporting cold chain management. This includes the procurement of modern refrigeration units, backup power systems, and transportation technologies that can help overcome challenges posed by unreliable electricity supply and outdated equipment. Ulep and Uy (2020) stress the importance of equipping health facilities with the necessary tools to ensure the integrity of vaccines, which is a fundamental aspect of the success of national immunization campaigns (Calzada, 2024; Espartero et al., 2024; Carpio et al., 2024).

In conclusion, Ulep and Uy (2020) advocate for a multifaceted approach to improving the Philippines' immunization efforts. This approach should include enhanced training, upgraded infrastructure, and increased support for cold chain logistics. By addressing these key challenges, the country can significantly improve its vaccine distribution system, leading to better health outcomes and more effective disease prevention programs (Garil et al., 2024; Bondoc Jr., 2024; Murro, 2024).

Methodology

1. *Research Design*

This study employed a quantitative research design to collect and analyze empirical data. By focusing on the manipulation and control of variables, the approach aims to validate results based on observations and measurements. The research emphasizes understanding the objective significance of experiences from the perspective of individuals.

According to Barrientos-Tan (2006), quantitative research methods are used to control and manipulate variables and to verify outcomes through systematic and empirical data collection. Additionally, Barrientos-Tan (2011) notes that descriptive surveys involve collecting self-reported data from participants in order to explore and describe real-life scenarios. This approach helps in providing a clear representation of the characteristics of specific situations, individuals, or groups within a population. It entails organizing and quantifying the gathered data through tools like questionnaires to enable a thorough analysis.

2. *Research Participants*

The research was carried out across the Rural Health Units in all 19 municipalities of Sulu. The participants in the study were nurses working within these units, with a total sample size of 100 individuals drawn from the population.

3. *Research Instruments*

A modified survey questionnaire was employed to address the research questions. The instrument was structured into two primary sections, each designed to gather information on the self-perceived competencies of nurses in Rural Health Units in Sulu. The first section focused on collecting demographic data about the respondents. The second section assessed the nurses' competency levels in cold chain management for vaccines. Respondents were asked to rate their responses using a 5-point Likert scale: 5.00 for strongly agree, 4.00 for agree, 3.00 for moderately agree, 2.00 for disagree, and 1.00 for strongly disagree.

4. *Data Gathering Procedure*

To assess the self-perceived competencies of nurses regarding cold chain management of vaccines in the Rural Health Units (RHU) of Sulu, a modified questionnaire was used as the primary data collection tool for this study. Prior to distribution, a formal letter requesting permission was sent to the heads of the respective RHUs. Once completed, the questionnaires were collected promptly to maintain confidentiality. All completed questionnaires from the 19 Rural Health Units were gathered and analyzed immediately after collection.

5. *Data Analysis*

To analyze the primary empirical data gathered in this study, the following statistical tools were utilized:

Descriptive Statistics: For addressing the first research question, descriptive statistics, specifically frequency and percentage distribution, were applied to analyze the socio-demographic profile of the participants. By categorizing variables such as age, length of service, and employment status, researchers can effectively summarize the data (Triola, 2018).

Mean and Standard Deviation: For the second research question, mean and standard deviation were utilized to evaluate the competency levels in temperature control, equipment management, quality assurance, and risk management among nurses involved in vaccine cold chain management. These statistical measures help to identify trends in competency levels, which can inform the creation of customized training programs and the optimal allocation of resources

to improve vaccine management (Triola, 2018; Sullivan, 2019; Smith & Smith, 2015; Mertler & Vannatta, 2016; Laerd Statistics, 2018; Khan Academy, n.d.).

ANOVA (Analysis of Variance): For addressing the third research question, ANOVA, an inferential statistical tool, was employed. ANOVA enables researchers to make predictions or generalizations about a population based on sample data. It compares the means of three or more groups to determine whether significant differences exist between them. This analysis assesses whether the observed differences in group means are true differences in population means or simply due to random variation. By evaluating the variance between group means compared to the variance within groups, ANOVA helps identify factors that influence the dependent variable (Gravetter & Wallnau, 2016). An independent t-test was also used for analyzing gender as a categorical variable.

Pearson's Correlation Coefficient: For the fourth research question, Pearson's correlation coefficient was applied to assess the strength and direction of relationships between continuous variables. The correlation coefficient ranges from -1 to +1, where +1 represents a perfect positive correlation, -1 indicates a perfect negative correlation, and 0 means no correlation. Pearson's correlation is typically used to measure linear relationships between continuous variables (Cohen, West, & Aiken, 2014).

Results and Discussion

Question 1. 1. What is the demographic profile of nurses in the Rural Health Unit in terms of Age, Gender, Length of Service, and Employment Status?

In terms of age

Table 1.1 Demographic Profile of Nurses According in Terms of Age.

Age of the Respondents	Frequency	Percent
29 y.o and below	32	32.0
30-39 y.0	50	50.0
40-49 y.o	7	7.0
50 y.o.	11	11.0
Total	100	100.0

Table 1.1 the demographic distribution of Rural Health Nurses in this study, specifically in terms of age, is essential for evaluating their awareness levels regarding cold chain management. The data indicates that the largest group of respondents (50%) falls within the 30 to 39-year-old range. This suggests that half of the nursing workforce is in the mid-stage of their careers, likely equipped with several years of practical experience and exposure to core healthcare protocols, including immunization and cold chain management.

A notable portion of the respondents (32%) is aged 29 years or younger, which highlights a significant presence of early-career nurses. These individuals may have recently completed their nursing education and could be more familiar with contemporary theories and updated guidelines related to cold chain management, depending on their educational backgrounds and clinical placements.

Conversely, only 18% of the respondents are aged 40 years or older, with 7% falling between 40 and 49 years, and 11% being 50 years or older. While this older group may bring a wealth of practical experience and institutional knowledge, their smaller proportion in the sample suggests that fewer highly experienced nurses are actively engaged in the surveyed healthcare facilities. This demographic trend points to a workforce that is primarily composed of younger to mid-career

nurses, which could influence the overall consistency and awareness of cold chain practices in clinical settings.

From this analysis, it can be inferred that the majority of the nursing workforce involved in the study is under 40 years old. This trend could be advantageous in terms of adaptability and willingness to embrace new practices related to cold chain management. However, variations in awareness may still exist due to factors such as clinical exposure, formal training, and institutional support. The lower number of older nurses may also limit the opportunities for mentorship and knowledge sharing, which are critical for reinforcing best practices in cold chain management.

Based on these findings, it is recommended that age-appropriate training programs be developed to ensure consistent awareness and competency across all age groups. Continuing education on cold chain management should be made mandatory and easily accessible, particularly for younger nurses who may still be building field experience, as well as for older nurses who may require updates on current technologies and protocols. Furthermore, mentorship programs should be promoted, where experienced nurses can guide less-experienced colleagues in applying cold chain practices effectively. Regular assessments of cold chain management practices in healthcare facilities are also essential to identify potential gaps in training and reinforce accountability in maintaining vaccine integrity and ensuring public health safety.

In terms of gender

Table 1.2 Demographic Profile of Nurses According in Terms of Gender.

Gender	Frequency	Percent
Male	14	14.0
Female	86	86.0
Total	100	100.0

Table 1.2 the distribution of respondents by gender in relation to their perceived competencies in cold chain management of vaccines in rural health settings in Sulu reveals a noticeable gender disparity. The data shows that a substantial majority of the respondents, 86%, are female, while only 14% are male. This reflects the gender imbalance typically observed in the nursing profession, especially in community-based and public health roles such as those in rural health units.

From this data, it is clear that rural health nursing in Sulu is predominantly performed by women. This underscores the importance of empowering female health workers through focused training, leadership development, and adequate resource allocation to enhance their proficiency in cold chain management. Although male nurses make up a smaller portion of the workforce, it is crucial that they also be included in professional development programs to ensure a well-rounded, skilled, and cooperative team.

Given the gender composition, it is recommended that training programs and capacity-building activities related to cold chain management be tailored to address the specific needs and dynamics of this workforce. This approach will help ensure that all nurses, regardless of gender, are equipped with the necessary skills and knowledge to maintain effective cold chain practices.

In terms of Length of Service

Table 1.3 Demographic Profile of Nurses According in Terms of Length of Service.

Length of service	Frequency	Percent
1	15	15.0

2	37	37.0
3	27	27.0
4	21	21.0
Total	100	100.0

Table 1.3 this section presents the distribution of rural health nurses based on their years of service. The data shows that most respondents have relatively short professional careers. Specifically, 37% of nurses have 2 years of service, while 27% have 3 years of service. Nurses with 1 year of experience account for 15%, and those with 4 years of service represent 21% of the respondents.

The findings suggest that the nursing workforce in rural health units in Sulu is still relatively young in terms of experience, with 79% of the nurses having 3 years or less of service.

When it comes to cold chain management, the length of service plays a significant role in shaping the nurses' self-perceived competencies. Nurses with more years of experience are likely to have encountered a wider range of situations related to vaccine handling, troubleshooting cold chain issues, and participating in immunization campaigns. In contrast, less experienced nurses may primarily depend on recent academic knowledge and short-term training, which might not provide the same level of confidence or practical understanding.

Considering this, it can be inferred that although the workforce consists largely of early-career professionals, there may be a lack of hands-on experience that could impact the nurses' confidence and perceived competencies in managing cold chain systems. Therefore, it is crucial to provide consistent, practical training and mentorship for nurses at all experience levels to maintain high standards of cold chain management.

Based on these insights, it is recommended that tailored in-service training programs be introduced, focusing on strengthening the practical skills of nurses with 1 to 2 years of service, helping them build confidence in cold chain management. Furthermore, establishing mentorship systems where more experienced nurses (those with 3 to 4 years of service) can support and guide newer staff would help improve skills and ensure the continuity of best practices. Retention strategies should also be explored to encourage longer careers in rural health units, which would contribute to a more experienced and stable workforce capable of ensuring vaccine integrity and optimal distribution.

In terms of Employment Status

Table 1.4 Demographic Profile of Nurses According in Terms of Employment Status.

Employment Status	Frequency	Percent
Permanent	18	18.0
job order	4	4.0
Contractual	69	69.0
Volunteer	9	9.0
Total	100	100.0

Table 1.4 this section presents the employment status of the rural health nurses who participated in the study on their self-perceived competencies in cold chain management of vaccines in Sulu. The data reveals that the majority of respondents (69%) are employed on a contractual basis, followed by 18% who hold permanent positions. In addition, 9% are volunteers, and 4% are working under a job order status. This distribution highlights the prevalence of non-regular employment within the rural health workforce in the region.

The significant proportion of contractual nurses indicates that many healthcare workers in Sulu are engaged under short-term or renewable contracts, which may affect their job security, access to professional development, and overall motivation. Volunteers and job order staff,

comprising 13% of the respondents, are likely to have limited institutional support, which could impact their participation in formal cold chain training and restrict their involvement in critical vaccine management tasks.

From these findings, it can be concluded that the rural health workforce in Sulu is heavily dependent on contractual workers, who may need additional support to ensure that their competencies in cold chain management match those of permanent employees. The relatively small number of permanent staff suggests a potential gap in workforce stability and continuity, which are vital for the success and sustainability of an effective cold chain system.

Therefore, it is recommended that local health authorities invest in inclusive capacity-building programs that cater to all types of employment, with particular focus on contractual and volunteer nurses who may be overlooked in traditional training frameworks. Furthermore, efforts should be made to increase the number of permanent positions to improve workforce retention and strengthen institutional knowledge. Regular training, supervision, and evaluation should be implemented to ensure that all nurses, regardless of employment status, maintain consistent competency in cold chain management and contribute to the integrity of vaccine handling across all service levels.

Question 2. What is the competency levels of the nurses in Rural Health Units on cold chain management of vaccines in the areas of Temperature control, Equipment Management, Quality Assurance, and Risk Management?

In terms of Temperature Control

Table 2.1 Competency Levels of Nurses in Rural Health Units in Sulu in terms of Temperature Control.

Temperature Control.	Mean	Std. Deviation	Rating
1. I know the appropriate temperature ranges for vaccine storage	4.4600	.74427	Agree
2. I monitor and record the temperature of vaccine storage units regularly	4.0800	.87247	Agree
3. I can identify and address temperature excursions effectively	4.1000	.78496	Agree
4. I make sure that ice packs are conditioned before used.	4.6100	.58422	Strongl agree
5. I use temperature monitoring device/s to ensure vaccines are safe for use.	4.2100	.86801	Agree
Total Mean Score	4.2920	.63527	Agree

Scale	*Descriptive Equivalent*	*Interpretation*
4.50-5:00	*Strongly Agree*	*Very high competency*
3.50 – 4.49	*Agree*	*High competencies*
2.50- 3.49	*Moderately Agree*	*Moderate competency*
1.50-2.49	*Disagree*	*Low competencies*
1:00-1.49	*Strongly Disagree*	*Very Low competency*

Table 2.1 this section presents the competency levels of nurses working in rural health units in Sulu with respect to temperature control, a vital aspect of effective cold chain management. The overall mean score of 4.2920, accompanied by a standard deviation of 0.63527, falls under the descriptive category of "Agree," indicating a generally high level of competency. This suggests that, on the whole, the respondents demonstrate a strong understanding and application of practices necessary to maintain proper temperature conditions for vaccine storage.

Among the five indicators assessed, the highest mean score was obtained for the statement, "I make sure that ice packs are conditioned before use," with a mean of 4.6100, categorized as "Strongly Agree." This result indicates a very high level of competency, suggesting that nurses

exhibit excellent awareness and execution of proper ice pack handling, which is critical for preserving the potency of vaccines during transport. Similarly, the statement, "I know the appropriate temperature ranges for vaccine storage," received a mean score of 4.4600, rated as "Agree," indicating a solid grasp of essential cold chain parameters.

Other indicators, including "I monitor and record the temperature of vaccine storage units regularly" (mean = 4.0800), "I can identify and address temperature excursions effectively" (mean = 4.1000), and "I use temperature monitoring device/s to ensure vaccines are safe for use" (mean = 4.2100), were all rated as "Agree." These responses suggest that, while nurses generally adhere to cold chain protocols, there may be slight inconsistencies or uncertainties, particularly in addressing temperature fluctuations or utilizing temperature monitoring equipment.

In summary, the data reveals that rural health nurses in Sulu possess a high level of competency in temperature control, which is fundamental to cold chain management. The results show that nurses are aware of and generally apply practices that ensure vaccine safety. However, the slightly lower mean scores in managing temperature excursions highlight areas where additional support and training could further improve their ability to handle unexpected temperature fluctuations or emergency situations.

It is recommended that health units enhance and expand competency-focused training programs, particularly those addressing real-world scenarios like managing temperature excursions and using advanced temperature monitoring technologies. Regular evaluations and refresher courses will help maintain consistently high standards across all rural health nurses, thereby ensuring the continued integrity of the vaccine supply chain.

In terms of Equipment Management

Table 2.2 Competency Levels of Nurses in Rural Health Units in Sulu in terms of Equipment Management.

Equipment Management	Mean	Std. Deviation	Rating
1. I am familiar with the various equipment used for cold chain management	4.1900	.74799	Agree
2. I can do routine maintenance on cold chain equipment.	4.1100	.80271	Agree
3. I make sure that all cold chain equipment is calibrated and functioning properly	4.3000	.75879	Agree
4. I know how to perform the Paper Test and what is the purpose of doing so.	4.0100	.95869	Agree
5. I ensure that all equipment used for transporting vaccines are safe and has no breaks (carriers and transport boxes)	4.5100	.64346	Strongly Agree
Total Mean Score	4.2240	.65089	Agree

Scale	*Descriptive Equivalent*	*Interpretation*
5	*Strongly Agree*	*Very high competency*
4	*Agree*	*High competencies*
3	*Moderately Agree*	*Moderate competency*
2	*Disagree*	*Low competencies*

1 Strongly Disagree Very Low competency

Table 2.2 this section highlights the competency levels of rural health nurses in Sulu with regard to equipment management, a crucial aspect of maintaining the integrity and effectiveness of the vaccine cold chain. The overall mean score of 4.2240, with a standard deviation of 0.65089, suggests general agreement among the respondents, indicating a high level of competency. This reflects the nurses' substantial understanding and confidence in managing, maintaining, and monitoring the equipment used in cold chain systems.

Among the various indicators assessed, the highest mean score was recorded for the statement, "I ensure that all equipment used for transporting vaccines are safe and free from damage (carriers and transport boxes)," with a mean of 4.5100. This falls under the "Strongly Agree" category, demonstrating a very high level of competency in ensuring that transport equipment is in optimal condition, which is vital for preserving vaccine potency during distribution, particularly in remote locations.

Other indicators, including "I ensure that all cold chain equipment is calibrated and functioning properly" (mean = 4.3000), "I am familiar with the various equipment used for cold chain management" (mean = 4.1900), and "I can perform routine maintenance on cold chain equipment" (mean = 4.1100), were all rated as "Agree," reflecting high levels of competency in handling and maintaining cold chain equipment. These results suggest that most nurses are confident in their roles as custodians of cold chain devices, ensuring their proper functioning for safe vaccine storage and transport.

The lowest mean score among the indicators was for the statement, "I know how to perform the Paper Test and understand its purpose," with a mean of 4.0100. Although still rated as "Agree," this slightly lower score may indicate a need for further training on specific procedures such as the Paper Test, which is an essential method for assessing the condition of vaccine carriers and cold boxes.

In conclusion, the data reveals that rural health nurses in Sulu display a consistently high level of competency in managing the equipment necessary for effective cold chain operations. This reflects their readiness and reliability in maintaining the tools crucial for vaccine preservation.

To further enhance these competencies, it is recommended that training programs incorporate more hands-on practice and demonstrations, particularly focusing on specialized techniques like the Paper Test. Regular calibration checks and preventive maintenance routines should be implemented, along with standardized protocols and checklists. Additionally, ensuring that all health workers, irrespective of their employment status or experience level, have access to continuous training on updated equipment will help maintain a high, uniform standard of care across all rural health units.

In terms of Quality Assurance

Table 2.3 Competency Levels of Nurses in Rural Health Units in Sulu in terms of Quality Assurance.

Quality Assurance	Mean	Std. Deviation	Rating
1. I understand the importance of adhering to cold chain protocols	4.5400	.61002	Strongly Agree
2. I conduct regular checks to ensure vaccine quality and integrity (Vaccine vial monitor and First Expiry First Out)	4.4100	.73985	Agree

3. I participate in training programs related to cold chain management	4.0500	.95743	Agree
4. I can interpret vaccine vial monitor accordingly	4.2000	.79137	Agree
5, I have a good knowledge of how to do Shake Test and why it is important.	4.3300	.76614	Agree
Total Mean Score	4.3060	.64099	Agree

Scale	*Descriptive Equivalent*	*Interpretation*
5	*Strongly Agree*	*Very high competency*
4	*Agree*	*High competencies*
3	*Moderately Agree*	*Moderate competency*
2	*Disagree*	*Low competencies*
1	*Strongly Disagree*	*Very Low competency*

Table 2.3 this section discusses the competency levels of rural health nurses in Sulu regarding Quality Assurance, a vital component of cold chain management that ensures the effectiveness and safety of vaccines. The overall mean score of 4.3060, with a standard deviation of 0.64099, falls within the "Agree" range, indicating a high level of competency among the respondents. This suggests that the nurses have a strong understanding and effective application of quality control practices within the cold chain system.

The highest-rated item was, "I understand the importance of adhering to cold chain protocols," with a mean of 4.5400, classified as "Strongly Agree." This score reflects a very high level of competency, demonstrating that nurses recognize the critical importance of following established protocols to maintain vaccine potency and public trust. This strong understanding of protocol is further supported by practical application, as indicated by the statement, "I conduct regular checks to ensure vaccine quality and integrity (Vaccine Vial Monitor and First Expiry, First Out)," which received a mean of 4.4100, also suggesting high competency in monitoring vaccine quality.

Other indicators of quality assurance, such as "I can interpret the vaccine vial monitor (VVM) accordingly" (mean = 4.2000) and "I have a good understanding of how to perform the Shake Test and its importance" (mean = 4.3300), were rated as "Agree," showing that most nurses are proficient in using standard tools and tests to assess vaccine quality. However, the item "I participate in training programs related to cold chain management" received a slightly lower mean score of 4.0500, although it still falls within the "Agree" range. This may point to some variability in the frequency or accessibility of training, which could affect the consistency of knowledge and skills.

In conclusion, rural health nurses in Sulu show a strong level of competency in quality assurance related to cold chain management, reflecting both awareness and the practical application of safety protocols. However, there appears to be room for improvement in participation in training programs, which is essential to maintaining up-to-date and standardized competencies.

It is recommended that structured, regular capacity-building programs be implemented across all rural health units to ensure that every nurse has the opportunity to refine their skills. Special emphasis should be placed on training for interpreting VVMs, performing Shake Tests, and applying the First Expiry, First Out (FIFO) principle. Strengthening access to continuous training will support professional growth and ensure that quality assurance practices remain consistent and effective at all stages of the cold chain process.

In terms of Risk Management

Table 2.4 Competency Levels of Nurses in Rural Health Units in Sulu in terms of Risk Management.

Risk Management	Mean	Std. Deviation	Rating
1. I can identify potential risks in the cold chain management process	4.2600	.70525	Agree
2. I am aware of the emergency procedures for vaccine storage failures	4.1900	.81271	Agree
3. I actively Participate in risk assessment activities related to vaccine management	4.2100	.76930	Agree
4. I know who to contact in case of emergency in cold chain management in the facility	4.3000	.77198	Agree
5. I am aware of the contingency plans in cold chain management	4.1500	.85723	Agree
Total Mean score	4.2220	.71627	Agree

Scale	*Descriptive Equivalent*	*Interpretation*
5	*Strongly Agree*	*Very high competency*
4	*Agree*	*High competencies*
3	*Moderately Agree*	*Moderate competency*
2	*Disagree*	*Low competencies*
1	*Strongly Disagree*	*Very Low competency*

Table 2.4 this section presents the competency levels of rural health nurses in Sulu regarding risk management within the context of cold chain vaccine management. The overall mean score of 4.2220, with a standard deviation of 0.71627, places the response in the “Agree” category, indicating a high level of competency in identifying and addressing risks associated with vaccine storage and handling.

All five indicators in this area fell within the “Agree” range, reflecting a consistent level of awareness and preparedness among the respondents. The highest-rated statement was, “I know who to contact in case of an emergency in cold chain management in the facility,” with a mean score of 4.3000. This demonstrates that nurses are well-informed about the reporting procedures and communication channels during cold chain disruptions, which are crucial for ensuring a swift and effective response.

Other indicators such as “I can identify potential risks in the cold chain management process” (mean = 4.2600) and “I actively participate in risk assessment activities related to vaccine management” (mean = 4.2100) also showed high competency levels. These responses suggest that nurses are actively engaged in preventative measures and understand the importance of identifying and mitigating risks to maintain vaccine integrity. Meanwhile, the items “I am aware of the emergency procedures for vaccine storage failures” (mean = 4.1900) and “I am aware of the contingency plans in cold chain management” (mean = 4.1500) indicated that nurses are generally familiar with institutional protocols designed to handle cold chain emergencies.

In conclusion, the data reveals that rural health nurses in Sulu demonstrate strong competencies in risk management. They are well-informed about the risks associated with cold chain management, aware of emergency procedures, and familiar with contingency plans. These

competencies are essential for ensuring vaccine efficacy and safeguarding public health by preventing potential risks.

To further strengthen these competencies, it is recommended that regular simulation exercises and emergency drills be organized to reinforce knowledge and prepare nurses for real-world scenarios. Additionally, ensuring that contingency plans are regularly updated and effectively communicated across all staff members will help maintain consistency in emergency responses. Increasing nurse participation in risk assessments and promoting collaborative problem-solving will also foster a culture of safety and accountability in the management of the vaccine cold chain.

3. Is there a significant difference in the level of competencies of Rural Health Unit nurses on cold chain management of vaccines when data are categorized by Age, Gender, Length of Service, and Employment Status?

According to Age

Table 3.1 Significant Differences in the Competency Levels of Rural Health Unit Nurses on Cold Chain Management based on age.

VARIABLES		Sum of Squares	Df	Mean Square	F	Sig.	Description
Temperature control	Between Groups	3.263	3	1.088	2.846	.042	Significant
	Within Groups	36.691	96	.382			
	Total	39.954	99				
Equipment Management	Between Groups	3.225	3	1.075	2.665	.052	Not Significant
	Within Groups	38.718	96	.403			
	Total	41.942	99				
Quality Assurance	Between Groups	3.340	3	1.113	2.862	.041	Significant
	Within Groups	37.337	96	.389			
	Total	40.676	99				
Risk Management	Between Groups	3.922	3	1.307	2.677	.051	Not Significant
	Within Groups	46.870	96	.488			
	Total	50.792	99				

Significance level set at $p < 0.05$

Table 3.1 this section presents the results of an analysis of variance (ANOVA) conducted to determine whether there are significant differences in the competency levels of Rural Health Unit nurses in Sulu on cold chain management based on age groups. The analysis covers four key domains: Temperature Control, Equipment Management, Quality Assurance, and Risk Management.

The findings reveal that there are statistically significant differences in the competency levels related to Temperature Control ($F = 2.846$, $p = .042$) and Quality Assurance ($F = 2.862$, $p = .041$). Both p-values are below the 0.05 significance threshold, suggesting that nurses' competencies in these areas vary according to their age group. This variation may be influenced by factors such as differences in experience, exposure to training, or generational familiarity with updated protocols and best practices. For example, younger nurses might be more familiar with

current training material, while older nurses may have more hands-on field experience, contributing to differences in competency levels across age groups.

In contrast, no statistically significant differences were observed in the domains of Equipment Management ($F = 2.665$, $p = .052$) and Risk Management ($F = 2.677$, $p = .051$), although the p-values are close to the 0.05 cutoff. This suggests that competency levels in these areas are relatively consistent across the different age categories, potentially due to standardized training methods or shared experiences within the rural health context.

Supporting this, a UNICEF report (2020) highlighted a positive relationship between age and cold chain competency, noting that older workers tend to be more adept at ensuring vaccines are stored at the correct temperatures. Furthermore, Sokhna et al. (2021) observed that older nurses were more knowledgeable about cold chain procedures and maintaining vaccine potency during storage and transportation.

In conclusion, the results suggest that age significantly influences nurses' competencies in Temperature Control and Quality Assurance, but not in Equipment Management or Risk Management. These findings point to the importance of tailoring training and development programs according to different age groups, focusing on leveraging the strengths of older nurses and addressing any gaps among younger nurses in specific areas.

It is recommended that cold chain management training modules be adapted to suit different experience levels or age groups, ensuring that both younger and older nurses are equally proficient across all competency areas. Additionally, mentorship programs could bridge generational knowledge gaps, fostering peer learning and sharing of best practices between experienced and newer staff. Given the near-significant results in Equipment Management and Risk Management, future studies with larger sample sizes or qualitative follow-up could further explore these domains to uncover any subtle differences or areas for improvement.

According to Gender

Table 3.2 Significant Differences in the Competency Levels of Rural Health Unit Nurses on Cold Chain Management based on gender.

Competency Area	Gender	N	Mean	Std. Deviation	t-value	df	Sig. (2-tailed)	Interpretation
Temperature Control	Male	14	4.1000	0.53060	-1.222	98	0.224	Not Significant
	Female	86	4.3233	0.64801				
Equipment Management	Male	14	3.8857	0.72627	-2.134	98	0.035	Significant
	Female	86	4.2791	0.62518				
Quality Assurance	Male	14	4.1143	0.70039	-0.575	98	0.566	Not Significant
	Female	86	4.2395	0.72132				
Risk Management	Male	14	4.2143	0.52309	-0.605	98	0.547	Not Significant
	Female	86	4.3209	0.65961				

Significance level set at $p < 0.05$

Table 3.2 this section presents the results of an independent samples t-test that examined whether there are significant differences in the competencies of Rural Health Unit nurses regarding cold chain management based on gender.

In the area of Temperature Control, female nurses ($M = 4.32$, $SD = 0.65$) had slightly higher mean scores than male nurses ($M = 4.10$, $SD = 0.53$). However, the difference was not statistically

significant (t = -1.222, p = .224), indicating that gender does not have a substantial impact on competency in this area.

A different trend was observed in the domain of Equipment Management, where female nurses (M = 4.28, SD = 0.63) scored significantly higher than male nurses (M = 3.89, SD = 0.73). The independent samples t-test revealed a statistically significant difference with a p-value of .035, which is below the .05 threshold (t = -2.134). This suggests that female nurses demonstrate significantly higher competency in managing cold chain equipment compared to their male counterparts. The difference could be attributed to factors such as greater involvement in routine vaccine handling and equipment-related tasks, or more frequent participation in training opportunities focused on equipment management.

For Quality Assurance, male nurses had a mean score of 4.11 (SD = 0.70), while female nurses scored slightly higher at 4.24 (SD = 0.72). However, this difference was not statistically significant (t = -0.575, p = .566), indicating that both male and female nurses perform similarly in maintaining vaccine quality standards.

Similarly, in Risk Management, male nurses scored an average of 4.21, while female nurses had a slightly higher score of 4.32. The t-test result (t = -0.605, p = .547) revealed no significant difference between the two groups in this competency area, suggesting that gender does not influence nurses' ability to identify risks and respond to emergencies related to cold chain management.

Kasahun et al. (2023) highlighted that gender can influence cold chain management performance, noting disparities in access to training and resources. Their study found that female health workers often face systemic limitations that hinder their ability to effectively manage vaccine cold chains. These challenges include limited access to technical training, fewer opportunities for supervisory roles, and insufficient access to cold chain equipment and infrastructure. Kasahun et al. emphasized the importance of gender-sensitive approaches in cold chain training and resource distribution to empower female health workers and improve the overall efficiency and resilience of cold chain systems.

In conclusion, the analysis shows that gender does not significantly affect competency levels in most areas of cold chain management. However, there is a notable and statistically significant difference in Equipment Management, where female nurses demonstrated higher competence. This could be due to role assignments or the frequency of exposure to cold chain equipment in daily healthcare tasks.

It is recommended that equal training opportunities be provided to both male and female nurses, particularly in technical areas like equipment management. Cross-training and the sharing of responsibilities across genders could help balance competencies and ensure that all staff members are equally prepared to handle the full range of cold chain management tasks.

According to Length of Service

Table 3.3 Significant Differences in the Competency Levels of Rural Health Unit Nurses on Cold Chain Management based on Length of Service.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.	Description
Temperature control	Between Groups	2.379	3	.793	2.026	.115	Not Significant
	Within Groups	37.575	96	.391			
	Total	39.954	99				

	Between Groups	2.244	3	.748	1.809	.151	Not Significant
Equipment Management	Within Groups	39.699	96	.414			
	Total	41.942	99				
	Between Groups	2.994	3	.998	2.543	.061	Not Significant
Quality Assurance	Within Groups	37.682	96	.393			
	Total	40.676	99				
	Between Groups	4.245	3	1.415	2.918	.038	Significant
Risk Management	Within Groups	46.547	96	.485			
	Total	50.792	99				

Significance level set at $p < 0.05$

Table 3.3 this section presents the results of an analysis of variance (ANOVA) to assess whether the competencies of Rural Health Unit nurses in cold chain vaccine management vary based on their length of service.

The analysis showed no statistically significant differences in competency levels across different lengths of service in three of the four domains assessed: Temperature Control ($F = 2.026$, $p = .115$), Equipment Management ($F = 1.809$, $p = .151$), and Quality Assurance ($F = 2.543$, $p = .061$). These p-values exceed the standard significance level of 0.05, indicating that nurses with varying years of experience—whether one year or four years—exhibited relatively consistent competencies in these areas. This may suggest that essential knowledge and skills are acquired early in service through standardized training and shared exposure to routine cold chain operations within rural health facilities.

However, a statistically significant difference was identified in the Risk Management domain ($F = 2.918$, $p = .038$), implying that nurses' abilities to identify, assess, and respond to cold chain-related risks are influenced by their length of service. This result suggests that practical experience accumulated over time contributes to stronger risk management competencies. More seasoned nurses may be better prepared to respond to emergencies and apply contingency protocols due to their prolonged exposure to real-world challenges. In contrast, newer nurses may lack the opportunity to develop these competencies beyond the theoretical level.

The findings are supported by several prior studies. Kasahun et al. (2023) observed a positive correlation between years of service and overall competency in cold chain practices, noting that healthcare professionals with five or more years of experience demonstrated superior knowledge of vaccine storage and handling. Likewise, Yugbare et al. (2021) emphasized that nurses with longer tenures adhered more rigorously to procedural guidelines, particularly in areas such as temperature monitoring and equipment troubleshooting.

In addition, Senega PATH (2022) reported that experienced healthcare personnel displayed greater reliability in maintaining storage standards and managing refrigeration systems—skills critical to ensuring vaccine potency. UNICEF (2020) echoed these findings, highlighting that longer-serving health workers were more adept at performing routine maintenance and managing equipment failures. Similarly, Mose et al. (2019) concluded that experience was a key factor in consistent adherence to cold chain protocols, particularly in responding to unexpected disruptions such as power outages or equipment malfunction.

Together, this body of research reinforces the idea that time in service enhances nurses' capabilities, particularly in areas requiring judgment, adaptability, and procedural memory—traits essential for effective risk management in cold chain systems.

In summary, the analysis reveals that while length of service does not significantly affect competencies in temperature control, equipment management, or quality assurance, it does play a key role in risk management. This distinction suggests that while foundational skills can be

effectively taught and adopted early in a nurse's career, risk-related competencies develop more gradually through experience.

Recommendations include integrating more robust risk management training into orientation and ongoing professional development programs, especially for newly hired or early-career nurses. Strategies such as simulation-based learning, emergency response drills, and mentorship initiatives led by experienced staff could help accelerate the development of risk management skills. These efforts would contribute to more consistent and reliable cold chain practices across all levels of experience, ultimately safeguarding vaccine efficacy and public health outcomes.

According to Employment status

Table 3.4 Significant Differences in the Competency Levels of Rural Health Unit Nurses on Cold Chain Management based on Employment Status.

		Sum of Squares	df	Mean Square	F	Sig.	Description
Temperature control	Between Groups	2.493	3	.831	2.129	.102	Not Significant
	Within Groups	37.461	96	.390			
	Total	39.954	99				
Equipment Management	Between Groups	3.150	3	1.050	2.598	.057	Not Significant
	Within Groups	38.793	96	.404			
	Total	41.942	99				
Quality Assurance	Between Groups	3.516	3	1.172	3.028	.033	Significant
	Within Groups	37.160	96	.387			
	Total	40.676	99				
Risk Management	Between Groups	4.265	3	1.422	2.934	.037	Significant
	Within Groups	46.526	96	.485			
	Total	50.792	99				

Significance level set at $p < 0.05$

Table 3.4 this section presents the findings of an Analysis of Variance (ANOVA) to determine whether the competency levels of Rural Health Unit (RHU) nurses in cold chain management differ significantly based on their employment status—categorized as permanent, contractual, job order, or volunteer. The analysis focuses on four critical domains: Temperature Control, Equipment Management, Quality Assurance, and Risk Management.

The results indicate no statistically significant differences in the domains of Temperature Control ($F = 2.129$, $p = .102$) and Equipment Management ($F = 2.598$, $p = .057$), as both p-values exceed the 0.05 threshold. Although Equipment Management is close to significance, the results do not provide sufficient evidence to confirm a meaningful difference. These findings suggest that RHU nurses, regardless of employment type, generally exhibit comparable competencies in managing vaccine temperatures and maintaining cold chain equipment. This consistency may reflect standardized protocols and training practices that are applied uniformly across different employment categories within rural health units.

In contrast, statistically significant differences were observed in the domains of Quality Assurance ($F = 3.028$, $p = .033$) and Risk Management ($F = 2.934$, $p = .037$). These findings imply

that employment status is a determining factor in how effectively nurses implement quality control measures (such as interpreting Vaccine Vial Monitors [VVMs], performing shake tests, and applying First Expiry, First Out [FEFO] methods) and manage risks related to vaccine storage and distribution. It is plausible that nurses in permanent or long-term contractual positions benefit from more frequent training, ongoing supervision, and practical exposure, which contribute to enhanced proficiency in these areas. Meanwhile, those in job order or volunteer roles may experience limited opportunities for skills development, impacting their performance in quality and risk management.

These results are supported by previous studies. For example, Kasahun et al. (2023) found that permanent staff displayed greater familiarity with cold chain procedures and were more likely to adhere to established safety protocols than their temporary counterparts. The stability and continuity associated with permanent employment were identified as contributing factors to this enhanced competency.

Similarly, Yugbare et al. (2021) emphasized that long-term employment offers repeated exposure to cold chain processes and technologies, allowing staff to refine their skills and become more adept in handling vaccines. Their study noted that permanent workers were more reliable in monitoring temperatures, calibrating equipment, and responding to cold chain disruptions.

A report by Senegal PATH (2022) also observed that permanent employees showed a higher level of proficiency in managing cold chain systems due to regular participation in refresher trainings and consistent involvement in immunization programs. In contrast, temporary staff—often excluded from capacity-building efforts—were found to have weaker knowledge and inconsistent adherence to cold chain procedures.

In conclusion, the analysis suggests that while employment status does not significantly affect nurses' competencies in temperature control and equipment management, it does have a notable impact on Quality Assurance and Risk Management. These areas may require more in-depth knowledge, decision-making skills, and consistent practical experience—conditions more often met by permanent or long-term employees.

Recommendations include the equitable inclusion of all RHU nurses, regardless of employment classification, in formal training programs and performance evaluations. Capacity-building initiatives should be extended to cover job order and volunteer staff, ensuring they receive adequate orientation, refresher training, and hands-on learning opportunities. Institutionalizing inclusive training and supervision frameworks will help foster competency consistency across the workforce and reinforce the reliability of cold chain management practices in rural health settings.

4.Is there a significant correlation among subcategories subsumed under the level of competencies of nurses on cold chain management of vaccines?

Table 4 Significant Correlation among Subcategories Subsumed under the Level of Competencies of Nurses on Cold Chain Management of Vaccines.

Variables		Pearson *r*	Sig	N	Description
Patient Factor	Equipment Management	.804**	.000	100	Very High
	Quality Assurance	.726**	.000	100	Very High
	Risk Management	.702**	.000	100	Very High

**Correlation Coefficient is significant at alpha .05
Correlation Coefficient Scales Adopted from Hopkins, Will (2002):

0.0-0.1=Nearly Zero; 0.1-0.30=Low; .3-0.5 0=Moderate; .5-0.7-0=High; .7-0.9= Very High; 0.9-1=Nearly Perfect

Table 4 this section presents the results of a Pearson correlation analysis conducted to examine the relationships among the four core domains of cold chain management competencies among rural health nurses: Temperature Control, Equipment Management, Quality Assurance, and Risk Management. The analysis demonstrates strong, positive, and statistically significant correlations among all competency domains at the 0.01 level (2-tailed).

The strongest relationship was observed between Quality Assurance and Risk Management ($r = .844$, $p = .000$), indicating that nurses who exhibit high competency in maintaining vaccine quality are also highly capable in identifying and mitigating risks related to vaccine storage and handling. This is consistent with the functional overlap between these domains, as both require vigilance, procedural compliance, and critical response skills to safeguard vaccine efficacy.

A similarly high correlation was found between Equipment Management and Risk Management ($r = .820$), suggesting that nurses proficient in managing and maintaining cold chain equipment are also well-equipped to handle operational risks. The close relationship between Equipment Management and Quality Assurance ($r = .812$) further reinforces the idea that mastery in technical equipment use is strongly linked to maintaining high standards of vaccine quality.

The correlation between Temperature Control and Equipment Management ($r = .804$) also reflects a significant association. This result underscores the importance of technical precision in managing both temperature and equipment, as these functions are inherently intertwined in cold chain logistics.

All correlation coefficients fall within a high range—from .702 to .844—indicating consistently strong and statistically significant interrelationships among the four domains. These results suggest that the competencies assessed do not exist independently but are interdependent and mutually reinforcing. A nurse demonstrating proficiency in one area is likely to exhibit corresponding strengths in other areas of cold chain management.

In conclusion, the findings highlight that all subcategories of cold chain competency are significantly and positively correlated. This underscores the value of integrated training and development strategies, where improving one domain can potentially enhance others through shared knowledge and skillsets.

Recommendations include adopting a holistic training framework that addresses all four domains Temperature Control, Equipment Management, Quality Assurance, and Risk Management in a unified approach. Training programs should emphasize the interrelated nature of these competencies, encouraging comprehensive understanding and cross-functional application. Such an approach is expected to not only improve individual performance but also enhance the overall reliability and efficiency of vaccine cold chain operations in rural health settings.

Conclusion

The study concludes that the participants, comprising Rural Health Unit Nurses in Sulu, were well-represented across key demographic factors such as age, gender, length of service, and employment status. Overall, the nurses demonstrated a high level of self-assessed competence in managing the vaccine cold chain, with an average rating indicating strong compliance. Notably, significant differences were observed in competence levels across demographic groups, particularly in areas like quality assurance and risk management. Additionally, a strong correlation was found among the various components of cold chain management competencies, highlighting

their interrelated nature suggesting that enhancements in one area can lead to improvements in others.

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