VACCINE MANAGEMENT PRACTICES AMONG HEALTHCARE WORKERS: A CASE OF HEALTH FACILITIES IN MOROGORO REGION, TANZANIA

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By

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DECLARATION

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CERTIFICATION

The undersigned certifies that he has read and hereby recommends for acceptance by the University of Rwanda a dissertation entitled, "***Vaccine management practices among healthcare workers: A case of health facilities in Morogoro region, Tanzania***" in partial fulfilment of the requirements for the award of Master's degree in Health Supply Chain Management.

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……..……..
(Supervisor)

Date: ……. 2022

DEDICATION

I dedicate this dissertation to my lovely wife Pamela W. Ariwa, my beloved children Elijah, Esther and Eliud, and my parents the late Mr. Nestory M. Wisandara and Mrs. Monica S. Wakara. Special dedication goes to the late Prof. Pierre Claver Kayumba from the University of Rwanda.

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ACRONYMS

30DTR	30 – Day Temperature Recorder
CCE	Cold Chain Equipment
DC	District Council
DPT	Diphtheria Pertussis Tetanus
DVS	District Vaccine Store
EPI	The Expanded Program on Immunization
EVM	Effective Vaccine Management
MoHCDGEC	Ministry of Health, Community Development, Gender, Elderly and Children
RCH	Reproductive and Child Health
RVS	Region Vaccine Store
SDPs	Service Delivery Points
TZS	Tanzanian Shillings
UNICEF	United Nations International Children's Emergency Fund
VIMS	Vaccines Information Management System
VVM	Vaccine Vial Monitor
WHO	World Health Organization

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ABSTRACT

Introduction: Effective vaccine management is essential in maintaining quality of vaccines and minimize wastages at service delivery points. This study aimed to assess vaccine management practices among healthcare workers at health facilities in Morogoro region, Tanzania.

Methodology: This was a descriptive cross-sectional study design conducted in Morogoro region. Data were collected using a researcher-administered structured questionnaire and additional data were abstracted from the Vaccines Information Management System (VIMS), and Fridge-tag®2. Descriptive and binary regression analysis was done using SPSS version 19 to determine significant predictors for vaccine wastage during storage at health facilities.

Results: Findings indicated that among 77 facilities 65 (84.4%) had functional refrigerators (SE of 0.365), only twenty-six (33.8%) had an alternative source of energy for the refrigerator at SE of 0.480. Majority 70 (90.9%) of vaccinators knew the WHO recommended storage temperatures at health facilities and 47 (85.5%) were able to read the maximum storage temperatures. The regression analysis showed a statistically significant difference between observed vaccine wastage and training of providers, correctly reading of high temperature alarm records on the Fridge-tag® 2 and availability of back up source of power for vaccine refrigerators.

Conclusion: Healthcare workers' practices on vaccine and cold chain management was moderate for temperature data reading and documentation, to good in terms of knowledge and presence of functional cold chain equipment (CCE). The gaps reported should be addressed by all stakeholders through mentorships, supervisions and official meetings to ensure the existing knowledge is put into practice and improve immunization services.

Keywords: Temperature, Vaccine, Vaccine Management, Cold chain management, Tanzania

CHAPTER ONE: INTRODUCTION

This introduction section discussed the background information, problem statement, research objectives, questions which guided the study, justification and importance of the study, scope of the study and outline of the study.

1.1 Background information

Vaccines are immunobiological perishable products that are used to prevent diseases by activating antibodies in the human bodies [1, 2]. When they are exposed to extreme temperatures beyond the recommended limits of between +2ºC and +8ºC, vaccines degrade and lose potency which cannot be restored [3, 4]. Since the loss of potency of vaccines can happen at any stage of the logistics management system i.e., storage, distribution or service delivery it is essential that an effective vaccine management system be established including the cold chain to reduce wastages and improve efficiency of the vaccination programs [5, 6].

Once affected by extreme temperatures, exposed vaccines can no longer offer protection to recipients against targeted diseases. Therefore, healthcare workers must ensure at all times that the cold-chain system is well maintained to preserve vaccine quality before it is being administered to children and other beneficiary groups.

To better understand the magnitude of vaccine wastages, WHO estimated presence of about 67% of vaccine deliveries which were likely to being damaged because of various factors including absence of quality management practices and handling policies [7] with cold chain failures in 5 countries accounting to the loss 2.8 million doses in 2011 [8]. In addition, the National Health Service of the United Kingdom costed vaccine wastages of around £6.3 million in 2019, of which

50% of wasted doses could be avoided through improvement of the cold chain system etc. [9]. No quantifiable data is available for vaccine wastages in African countries.

Many countries have reported various challenges in vaccine management including poor storage condition, and non-monitoring of temperatures [10, 11]. One study conducted in the United States showed 63% of vaccine refrigerators operated below the minimum limit while 59% operated above the maximum limit. In addition, 93% [11] operated either below or above the recommended ranges

A study in Maharashtra, India reported 60% performance in temperature monitoring at health facilities while another study that was conducted in Amhara, Ethiopia reported that 48% of healthcare workers knew the correct storage temperature of vaccines (2°C - 8°C) and 38% had adequate knowledge on effective cold chain management [10]. Further, a study conducted by [12] reported that exposure of vaccines to freezing temperatures was at 13.5% in developing countries.

Further, various studies mentioned weaknesses in the cold chain management to include lack of knowledge among health workers [10, 13, 14] cold chain failure [10, 11, 13], quality of refrigerators, power interruption, [13], and too long storage at the health facility to be the main factors facilitating vaccine wastages.

The Tanzania Effective Vaccine Management Assessment [15] reported a 94% performance in temperature monitoring at health facilities with most of them lacking proof of corrective actions taken by healthcare workers to avoid vaccine wastage during temperature excursions. Currently, there is no country published data explaining the magnitude of vaccine wastage at health facilities in Tanzania due to poor management practice by healthcare workers and thus the country relies primarily on the WHO global wastage estimates for demand forecasting. In addition, there are no

studies which explains how healthcare workers use routinely collected temperature data from available devices and tools to make informed decision to minimize vaccine wastage occurrences.

The Tanzania Immunization Strategy 2021-2025 reported main reasons for vaccine stock out and wastage included of submission of inaccurate orders by not updating the VIMS, distribution matrix not adhered and mal-distribution by higher stores, and poor stock handling causing expiry and VVM change to discard point [16]. It was further reported that poor vaccine management practices by healthcare workers were mainly due to inadequate knowledge and practices including reading of VVM stickers, and interpretation of the data, poor temperature monitoring practices, including responding to alarms, temperature monitoring charts not properly filled etc.

With the observed performance at various levels, this study aimed to assess vaccine management practices at public health facilities in Morogoro region.

1.2 Problem Statement

In 2014, the WHO produced its compliance report on effective vaccine management that indicated achievement in just 33% with only 14% countries achieving temperature control criteria in the cold chain at low- and lower-middle-income countries, indicating inefficient cold chain equipment to protect childhood vaccines from heat or freeze damage [17]. Earlier, the WHO (2011) estimated presence of about 67% of vaccine deliveries which were likely to be damaged because of various factors including absence of quality management practices and handling policies [7] with cold chain failures in 5 countries accounting to the loss of 2.8 million doses [8]. These findings were further complimented by the National Health Service (2019) estimated a vaccine wastage that costed nearly £6.3 million pounds with the report also showing that improvement in the cold chain management alone could evade up to 50% of the loss of vaccine in the health system [9].

The World Health Organization (WHO) reports that this challenge is largely caused by weak logistics management of the vaccine cold chain system in both developed and developing countries [2, 18]. Most studies in African countries do not report the quantity and costs of vaccines wasted in association with the cold chain failures, or poor management practices of the cold chain equipment.

This study was based on an assumption that wastage of vaccines doses at health facilities was influenced by three factors of health workers training on vaccine handling and cold chain management, correct reading of high temperature alarm records on Fridge-tag® 2 devices and presence of back up source of power for vaccine refrigerators. The null hypothesis was H_0 = there is wastage of vaccine doses at health facilities, and the alternative hypothesis was H_1 = there is no wastage of vaccine doses at health facilities.

1.3 Research Objectives

1.3.1 Overall Objective

The main objective of this study was to assess temperature monitoring during storage, availability of vaccines, vaccine wastage rates and knowledge and practice among healthcare workers at health facilities in Morogoro region, Tanzania.

1.3.2 Specific Objectives

The specific objectives included the following: -

1.3.2.1. To identify the temperatures used for storage of childhood vaccines at health facilities

1.3.2.2. To determine availability of vaccines for children vaccination at public health facilities

1.3.2.3. To determine vaccine wastage rate at public health facilities for six-month prior the study

1.3.2.4. To determine the knowledge, and practices of healthcare workers on appropriate vaccine management procedures at health facilities

1.4. Research Questions

The following research questions were designed to guide data collection from participants

1.4.1. Specific research questions

1.4.1.1. What is the storage temperature of routine vaccines at public health facilities?

1.4.1.2. What is the status of vaccine availability at public health facilities?

1.4.1.3. What is the calculated vaccine wastage rate of routine childhood vaccines?

1.4.1.4. What is the existing knowledge and practice of health workers with respect to vaccine management?

1.5. Significance of the study

Various studies all over the world mention the importance of temperature monitoring for effective vaccine management during entry in the country down to the point of consumption. The World Health Organisation [19] recommended that countries use continuous temperature monitoring devices e.g., 30 DTR at health facilities to enable health workers to assess vaccines exposure and responding to CCE failure during storage.

In this regard, this study was conducted to assess healthcare providers' practices towards vaccine management during vaccine storage at health facilities. Variables which were being investigated included temperature performance, stock availability and management, vaccine wastage rate and the knowledge of healthcare workers who handles vaccines. The findings of this study will be

shared with vaccinators and their supervisors at district level, and region health management teams as well as PORALG and the Ministry of Health, and Immunization Partners with the aim to improve healthcare workers' knowledge and practices on vaccine management.

CHAPTER TWO: LITERATURE REVIEW

This section discusses various reviewed studies which are related to vaccine management. The main sections include an overview to the chapter, definition of the key terms and the main review section. In addition, section three presents a detailed review of various studies conducted at the regional and global levels. This chapter ends with a conceptual framework that was developed by the researcher.

2.1 Definition of terminologies

(i) **Effective Vaccine Management (EVM)**

Is a global initiative for assessment and monitoring of vaccine supply chain system aimed to identify operational and policy strengths and weaknesses, and the development of improvement plan to improve the performance [20].

(ii) **Vaccines**

Are biological preparations, created from parts or whole cells of living organisms, that are introduced into human bodies to enhance immunity against communicable diseases and either prevent (prophylactic vaccines) or, in some cases, treat disease (therapeutic vaccines) [21].

(iii) **Vaccine Vial Monitor**

A scientific timing and temperature integrated indicator with a heat-sensitive substance on the surface and a reference ringed around [22].

2.2 Literature review

Immunization is recognized as one of the most cost-effective health intervention which saves millions of lives every year [8]. When properly managed vaccination services decrease costs

incurred by both the caretakers and the governments by reducing the incidence of diseases in the communities [23]. However, health workers and supervisors need to maintaining the quality of vaccines because of challenges it employs on immunization programs in both developed and developing countries.

Currently, the world enjoys the benefits of global eradication of smallpox and is making efforts to eradicate polio caused by the wild-polio virus. It is essential to note that a well-functioning cold chain system prevent deterioration of vaccine quality by exposing them to freezing and/or high temperature exposure which cause adverse reactions to the products by irreversibly denaturing the proteins in the vaccine [8, 24, 25].

To ensure appropriate vaccine management, the health systems must establish appropriate health technologies for storage of vaccines and monitoring temperature during storage, have health workers who have adequate knowledge and skills on vaccine management practices, availability of vaccine management guidelines and standard operating procedures (SOPs) in place etc. In addition, health workers must implement appropriate practices and attitude to influence effective management responses whenever observed temperature records are beyond +2ºC and +8ºC range that is recommended by the WHO [10].

2.2.1. Temperature monitoring during vaccine storage at health facilities

Public health experts believe that inappropriate handling of vaccine during storage is the main cause of waning in the vaccine potency which is related to outbreak of vaccine preventable diseases reported in various communities. [26] In addition, the World Health Organization (WHO) recommends that childhood routine vaccines should be stored between +2°C to +8°C, except Oral Polio vaccines (OPV) so as to preserve their quality, efficacy, and safety [3, 10, 27].

A study In Ethiopia [10] reported that 35 of facilities which is equivalent to 58.3%, managed their vaccine cold chain systems suitably while 25 facilities equivalent to 41.7% acted inappropriately. The study further reported that most of facilities (90%) had functional thermometers for temperature monitoring, and 66.6% had vaccines with good VVM status. Also, a baseline study that was conducted in Tunisia [28] reported a 63.2% of the total time used by vaccinating health facilities to store vaccines within the recommended range of +2 to +8°C. The same study further reported that, 60% of vaccine storage refrigerators recorded negative temperature excursions during the study period.

A study by Kanja *et al* [29] in 2021 reported that all vaccinating facilities had 30DTR devices for temperature monitoring. In addition, the report stated that only 62% of facilities monitored their temperature twice daily for all days including weekends and public holidays, and 53% reviewed the observed heat or freeze alarms and corrective actions were recorded by the healthcare workers.

A study in Nigeria reported that, presence of devices/tools and the proper temperature monitoring practices are likely identify extreme temperatures which allows health workers to take appropriate and immediate actions to avoid damage of the stored vaccines [23]. Another study in Tunisia reported that, a significant decrease in accidental freezing of vaccines in the cold chain due to the use of continuous temperature monitors and freeze prevention technologies [28].

According the NIS strategy 2021-2025, [16] healthcare workers in Tanzania have inadequate knowledge and practices on various temperature monitoring aspects including reading and interpretation of VVM stickers attached on vaccine vials, and ineffective temperature monitoring practices including poor response to temperature excursions, not properly filling and archiving of temperature monitoring charts at health facilities.

2.2.2. Vaccine stock availability at health facilities

Vaccine supply chains are essential in ensuring functional immunization services by improving access to primary health-care services through consistent and uninterrupted supply of vaccines to all communities [30]. Immunization programs must use correct information about stock levels to ensure health facilities have essential vaccines at the right quantity at the right time through innovations in the vaccine supply chain systems to reduce vaccine stock-outs [31]. The vaccine availability review in the African region [32] reported Common causes of vaccine stock-outs at health facility level to include lack of trained healthcare workers, delayed vaccine deliveries to facilities, poor stock management by facility staff, and poor supply chain infrastructure. The same study further reported that when there is no national vaccine shortage, the main reasons for vaccine shortages and stock-outs at district and facility levels include poor stock management. These shortages may likely go on unreported, and undetected for longer periods and later affect immunisation coverage at all levels.

It was further reported by Iwu *et al* [33] in 2020 that only 27 (44%) regularly health facilities filled stock cards, and 49 (77%) reported at least one vaccine stock-out on the day of the visit. Further, health facilities reported delays in receiving vaccine supplies from the district store as the common challenge that contributed to stock-outs, with BCG and OPV vaccines being mostly affected at 37 (58%) and 28 (44%), respectively. In addition, the study conducted at public health facilities in Nairobi City County reported that most facilities experienced stock out of vaccines and accessories with the most affected vaccines being Oral Polio Vaccine (79%), Measles-Rubella (81%), and Tetanus (88%). [29]

Vaccine availability and accessibility are the drivers to good performance observed in many districts. For many years, Tanzania has experienced good immunization coverages of up to 88% for Measles-Rubella vaccine in 2019, but coverage of the same has fallen to 83% in 2020. During 2018 and 2019, the country experienced a stock out of both OPV and MR and related supplies for a duration of one-month or more at health facility level. Annual evaluation report indicated that stock out of vaccine and the Covid-19 impact were associated with this decrease [16].

2.2.3. Vaccine wastage rates at healthcare facilities

The World Health Organisation (WHO) defines vaccine wastage as the proportion of doses discarded in opened or unopened vaccine vials that are not used to vaccinate an eligible individuals [34]. The vaccine wastage is one of important parameters that guide forecasting of vaccines and related immunization supplies, with its absence at the national or local data on wastage rates, or incorrect numbers being used, there is a likelihood of the country to face serious vaccine shortages or being unable to fully consume the received quantities [35].

In 2005, the World Health organisation (WHO) estimated that nearly 50% of the produced vaccines were wasted globally, despite of existing tools to minimize wastages [34]. Globally, various studies have reported different levels of vaccine wastages in different countries. A study conducted in India indicated the overall wastage rates of BCG, Measles-Rubella, OPV, TT and Pentavalent to be 37.1%, 40.5%, 50.8%, 34.1% and 18.4%, respectively in Kangra district [36]. A six-months study conducted in Northern India reported the wastage rate at health facility level for Pentavalent vaccine to be 8%, and interestingly BCG had a wastage rate of 60% that was observed to be over the permissible levels [35].

In Tanzania, the vaccines wastage rates are estimated by the Ministry officials and used for forecasting at all levels of the immunization system may sometimes create overstocking of understocking of commodities.

2.2.4. Knowledge and skills of healthcare workers on effective vaccine management

Various studies have reported the role of health workers' experience in vaccine management at primary health facilities. A study in Edo State, Nigeria reported that improved cold chain management practices was observed to health workers' who were overseeing vaccines for the period of 5 years and below [23]. It was further reported by another study in Nigeria that about 65.0% of health care workers received training on vaccine management; and also 66.1% of the participants were observed to have good vaccine management practices [26].

These findings are supported by the study conducted in Ethiopia that indicated, 63.3% of health workers were trained on EPI [10]. In addition, a study in Odo State in Nigeria reported that, the level of education was likely to influence good practice in the cold chain management [23]. Poor knowledge on effective vaccine management may result to incorrect handling practices as reported by Ogboghodo [23] where healthcare workers reported the use of ice blocks (7.6%) to maintain vaccine temperature which is likely to cause accidental freezing. In addition, healthcare providers in the same study reported the use of inadequate number of ice packs for cold temperature maintenance (49%), and observed poor vaccine vial monitor (VVM) condition (33%).

2.3 Conceptual framework

A conceptual framework is an arrangement which describes the natural progression of the phenomenon under study [37]. It is used to address the expert's association of variables on the most

ideal approach to explain a phenomenon. Based on review of the literature above, the researcher designed the following conceptual framework. According to this framework, knowledge and skill of HCWs are anticipated to influence vaccine wastage because most responses to minimize wastage need them to have a clear understanding of why excursions happened, and what necessary actions to take. However, various intermediate factors including availability of temperature monitoring tools and devices, and effective supply chain system that ensure adequate and potent vaccines are always at healthcare facilities.

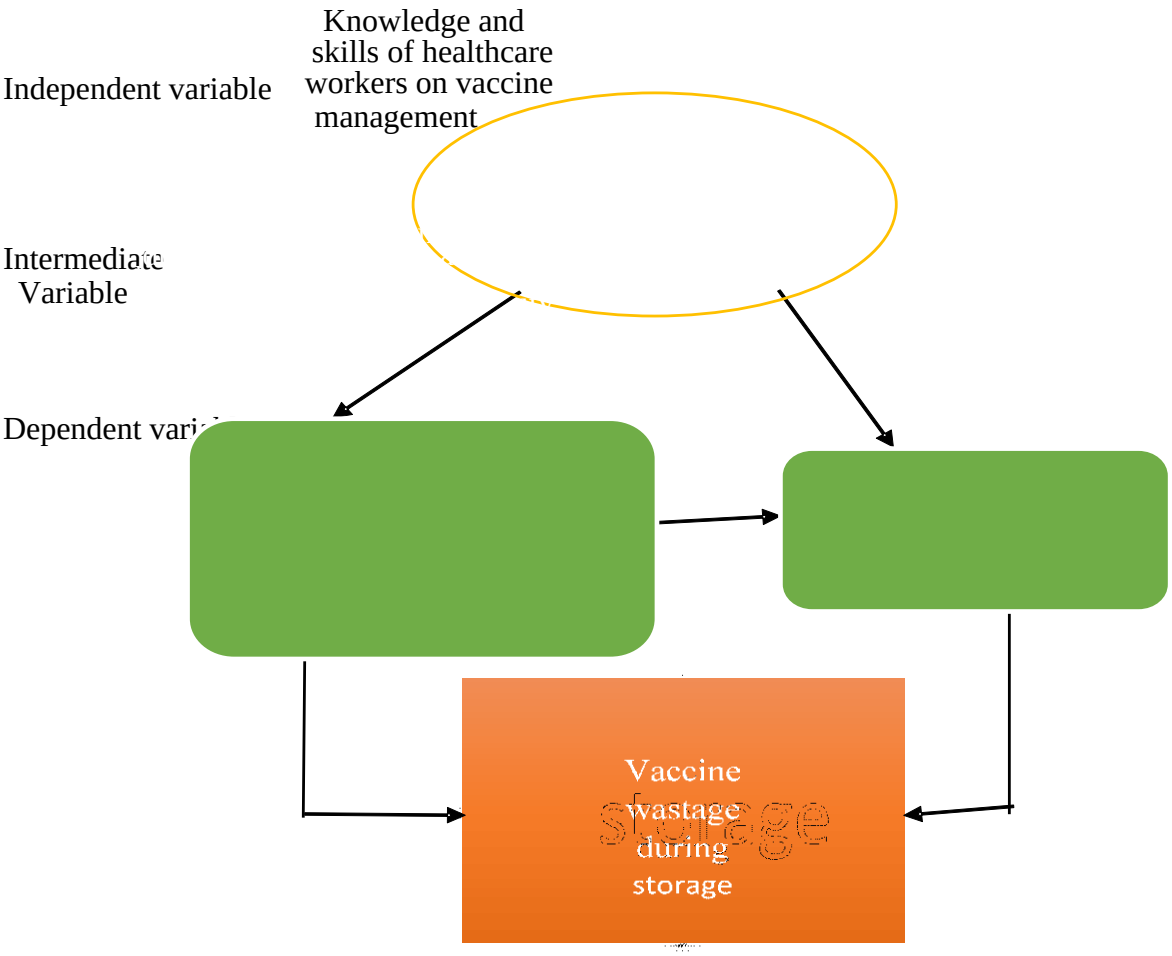

Figure 2.3. 1 The study conceptual framework developed by researcher, July 2021

CHAPTER THREE: RESEARCH METHODOLOGY

This part presents and clarifies the research design, target population, sampling and sample size, data collection, data analysis and ethical consideration.

3.1 Research design

Research design is described as the organised plan for data collection and analysis. According to [38] a research design is the researcher's strategy for an enquiry to achieve and understand a phenomenon under observation using both social and scientific approaches.

This was a descriptive cross-sectional study conducted between 01st September to 30th November 2021, and review of stock and temperature data for period of March to September 2021, using a quantitative approach to analyse the quantitative data that was collected through the questionnaire, and analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 19 [38]. Described quantitative research as the process of numerical data collection and analysis to explain a phenomenon where the methods are based on randomized samples, statistical inferences and interpretation of findings.

3.2 Location of the study

Morogoro region is situated at the Eastern part of Tanzania. The region is located between latitude 5º58" and 10º00" South of the Equator and longitude 35º25" and 35º30" to the East. The region has a total of nine districts of Ulanga, Mvomero, Morogoro municipality, Morogoro district, Mlimba, Malinyi, Kilosa, Ifakara, and Gairo all with a total of 345 vaccinating facilities and 388 vaccinators. All healthcare facilities receive vaccine stocks and related supplies every month from the district vaccine stores (DVS). After reaching the facility, the District Immunization and

Vaccination Officers (DIVO) examines the number of remaining doses of each antigen and performs an informed push system to refill orders to the maximum stock levels, that are established based on the number of targeted children available within the catchment area.

The facilities in Morogoro are providing routine childhood vaccination daily, while facilities with low number of target population provide vaccination two to five times weekly. In addition, most facilities provide BCG and MR vaccines once to twice, weekly depending on the number of children that attended session. This study was conducted at public health facilities that manage routine vaccines and provide immunization services to children and other beneficiaries including teenage girls, and pregnant women in the sampled districts of Malinyi, Morogoro and Gairo.

3.3 Study population

A population is described as all individuals from an especially depicted class of individuals, occasions, or articles on which the speculation is made [39]. The study population for this study were vaccinators from 345 health facilities that were providing immunization services in Morogoro region between 01st September – 30th November 2020. From this population 77 study participants were sampled and recruited into the study.

3.4 Sampling strategy

Initially, the three districts of Malinyi, Gairo and Morogoro district were purposively sampled based on their immunization coverage status of best, medium and poor, using DTP3 vaccination coverage data for the year 2020. Among the three selected districts, health facilities were selected using simple random sampling method without replacement from a list of vaccinating healthcare facilities available in each district. At every selected facility, one healthcare worker was

purposively selected in case the facility had only one vaccinator or randomly selected in case there were more than one vaccinator per facility.

Table 3.4. 1District immunization coverage (DTP3) in 2020

S/No	Region	Districts	Surviving Infants	Children vaccinated with Penta3	Penta3 coverage (%)
1	Morogoro	Malinyi DC	4,331	4,826	111%
2	Morogoro	Kilombero DC	10,823	9,813	91%
3	Morogoro	Ulanga DC	5,696	4,948	87%
4	Morogoro	Ifakara TC	3,490	2,953	85%
5	Morogoro	Gairo DC	9,833	8,179	83%
6	Morogoro	Morogoro MC	11,205	9,149	82%
7	Morogoro	Mvomero DC	12,920	10,024	78%
8	Morogoro	Kilosa DC	17,780	12,896	73%
9	Morogoro	Morogoro DC	11,216	8,122	72%

Included into the study were one health worker from each facility who provided vaccination services and/or maintaining the cold chain equipment and had at least one-year immunization or vaccine handling experience.

3.5 Sample Size

Various factors influence sample size estimation during research designing. The factors may include type of study design, availability of resources including study duration, human and financial resources, etc [39].

The sample size was calculated using Raosoft software [40], an online sample size calculator to determine the number of facilities included in the study. This study assumed a standard deviation of 1.96 for 95% confidence level, and a margin of error of ± 5%. The response rate of participants was assumed at 50% based on a similar study which was available at the time this study was being conducted. After calculation and consideration of above-mentioned parameters a sample size of seventy-seven participants were established for data collection as indicated in the Table below: -

Table 3.5. 1The number of facilities in selected districts

S/No	District name	Total number of vaccinating facilities	Number of sampled facilities
1	Gairo	27	22
2	Malinyi	11	9
3	Morogoro	58	47
		96	**78**

3.6 Consideration for inclusion into this study

The facilities included were those providing vaccination services for the minimum period of one-year and must have a device for temperature monitoring. In addition, healthcare workers responsible for vaccination services and with a minimum of one-year practice were included into the study.

3.7 Types of data

The researcher employed both primary and secondary data to meet objectives of this study.

3.7.1 Primary data

The primary data were obtained by the use of questionnaire which were administered by the researchers to all respondents in the study area. To achieve the intended objectives of this research the questionnaire elicited data on storage temperatures of vaccine, stock availability and knowledge of vaccinators.

3.7.2 Secondary data

The researchers also collected secondary data from participating facilities to supplement the primary data that was collected through questionnaires. Secondary data were gathered from various immunization data collection tools available at health facilities including stock ledgers, the Vaccine Information Management System (VIMS), monthly vaccination reports, and vaccines inventory data. Additional, secondary data were collected from monthly temperature reports, Fridge-tag® 2 devices, and Coldtrace-5 and alternative electronic Remote Temperature Devices (RTMDs) were used to capture temperature data at facilities.

3.8 Data collection tools

The data for this study was collected by using a structured questionnaire as indicated in Appendix 4 and 5, for English and Swahili versions, respectively. The questionnaire consisted of six main sections namely socio-demographic variables, knowledge on vaccine management, refrigerator characteristics and performance, temperature performance and data use for decision-making.

3.9 Validity

Different authors [39] have established the concept of study validity in different form including the degree to which a concept and proof, altogether are used to interpret a test scores. The term validity in research is synonymous to the words dependability, reproducibility, consistency or replicability over a period of time, using variable instruments and groups of participants while producing similar results.

Before data collection process the researcher consulted two immunization experts on from the National Immunization Program and another from Morogoro region to review the questionnaire and make inputs. In addition, the questionnaire was piloted to five vaccinators in Morogoro municipality to test its validity in the similar environment as the study area. Their responses were reviewed and it was found that they were matching to research questions posed by researchers.

3.10 Reliability

Cohen *et al* [41] explains reliability as a measure of study consistency over time and over similar samples. The tools in this study were also tested for reliability to determine if the questions were clear and understandable. The Cronbach's Alpha coefficient was computerized by using SPSS software to ascertain how items correlate to one another. For our study, the computerized coefficient was found at 0.798 which is slightly greater than 0.7.

Table 3.10. 1Reliability statistics of data tools

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.798	0.799	6

3.11 Data collection techniques

This study used three methods of research data collection including review of available information available at health facilities, observing/reading temperature monitoring devices and administering of written questionnaires to vaccinators.

Vaccine stock records supplied to facilities were obtained from the ledgers available at health facilities and triangulation performed through review of supply records in the VIMS. The facility's monthly vaccination reports were used to obtain vaccination records of children during the study period. Temperature data was captured through observation of temperature records (charts) and reading temperature monitoring devices including Fridge-tag® 2 and the Coldtrace-5. Other study parameters were captured through administered structured questionnaires to vaccinators working at sampled facilities, where only one healthcare worker was allowed to respond.

3.12 Data analysis

Data was sorted, checked, and coded and later entered into SPSS version 19. Further, study variables including temperature exposure of vaccines, stock availability, knowledge of healthcare workers were categorized and described by using SPSS. Facilities and vaccinators' demographic characteristics regarding vaccine management practices at health were analysed using descriptive statistic. Data triangulation was performed for temperature records and vaccine stock data found in paper tools available at health facilities and electronic records in Fridge-tag® 2 that was found at the facility or through the dashboards of ColdTrace-5, and the VIMS system.

The vaccines used in this study were BCG, MR, DTP-HepB-Hib, Rotavirus, and Sinopharm with the main selection criteria of these vaccines being their variability in terms of number of doses per

vial/ampoule, and vaccine characteristics after dilution of the vial. BCG was selected because it was lyophilised vaccines with 20-doses and the vial must be discarded within 6-hours after dilution. Measles-Rubella, was a 10-doses, lyophilised vaccine that should also be discarded within 6-hours after dilution, and had fewer doses compared to the BCG vaccine. DTP-HepB-Hib was a 10-doses vaccine that obeys the WHO-UNICEF conditions for a Multi-dose vial policy that allows it to be used up to 28-days after vial opening when specific use-conditions for a multi-dose vial policy are observed by healthcare workers. Rotavirus vaccine was available in a single-dose ampoule that was being given to children during vaccination sessions, and lastly Sinopharm a recently introduced vaccine into the Expanded Program on Immunization (EPI) to fight the COVID-19 pandemic. In addition, various studies on vaccine stock availability have used these antigens except the COVID-19 vaccines which were being recently introduced.

Wastage of vaccines at health facilities was analysed by using regression analysis via SPSS, through which the hypothesis was formulated and tested for the significance of vaccine wastage.

Null hypothesis H_0=there is wastage of vaccine doses at health facilities

H_1=there is no wastage of vaccine doses at health facilities

This hypothesis was tested by using linear regression analysis, which is given by the following formula: -

$$Y=aX_1+Bx_2+cX_3+e;$$

Whereby;

- Y is measured by the total number of vaccine doses wasted at healthcare facilities (in this case HPV vaccine used)

- X_1 was measured by total number of health facilities whose health workers were trained on vaccine handling and cold chain management
- X_2 was measured by total number of health facilities whose health workers correctly read high temperature alarm records on the Fridge-tag device
- X_3 was measured by total number of health facilities with back up source of power for vaccine refrigerator

The Null hypothesis H_0 is rejected if R square is less than 0.5

Thereafter, calculation of facility level vaccine wastage rate was done using the WHO-recommended formulas [42] where the monthly vaccine stock records and number of children vaccinated during the six-months period were included and applied using the following formula provided below: -

$$= 1 - \left[\frac{(number\ of\ doses\ administered)}{(monthly\ opening\ balance\ of\ doses + number\ of\ doses\ received\ in\ month) - (monthly\ closing\ balance\ of\ doses)}\right]$$

The calculation was performed using the number of vaccinated children, vaccine doses received and consumed at every facility involved in this study.

3.13 Logical and ethical considerations

Before execution of this study, the researcher applied for the permits from the Research Review Section of the President's Office, Regional Administration and Local Government (PORALG). Thereafter, introduction letters were requested from the health departments of the Morogoro Regional Secretariat (RS) and respective District Administrative Offices.

Thereafter, the researcher sought research permits from district health authorities in Morogoro region. Study participants were orally informed about this study and given the consent forms prior to being interviewed. They were also given the right to proceed or withdraw from this study at any time because their participation was voluntary.

CHAPTER FOUR: RESULTS PRESENTATION AND INTERPRETATION

This chapter presents the findings of the study. The chapter is organized into three sections including the descriptive analysis of facilities and health workers involves into the study, analysis and the descriptive and inferential statistics of study variables.

4.1 Demographic Information

This study collected information about respondents and facilities involved. These includes gender, working experiences, level of education, and professions of HCWs. Additional, information collected include Models of CCE and their functionality status.

Findings in Figure 4.1.1 indicated that, majority (70%) of participants were female practitioners. In addition, all vaccinators were trained in health services delivery with 54.5% and 45.5%, certificates, and diplomas, respectively. Most (40%) participants were nurses while the number of participating midwives were the least (10%). It was also observed that majority (60%) of participants had an immunization working experience of 5-years and more.

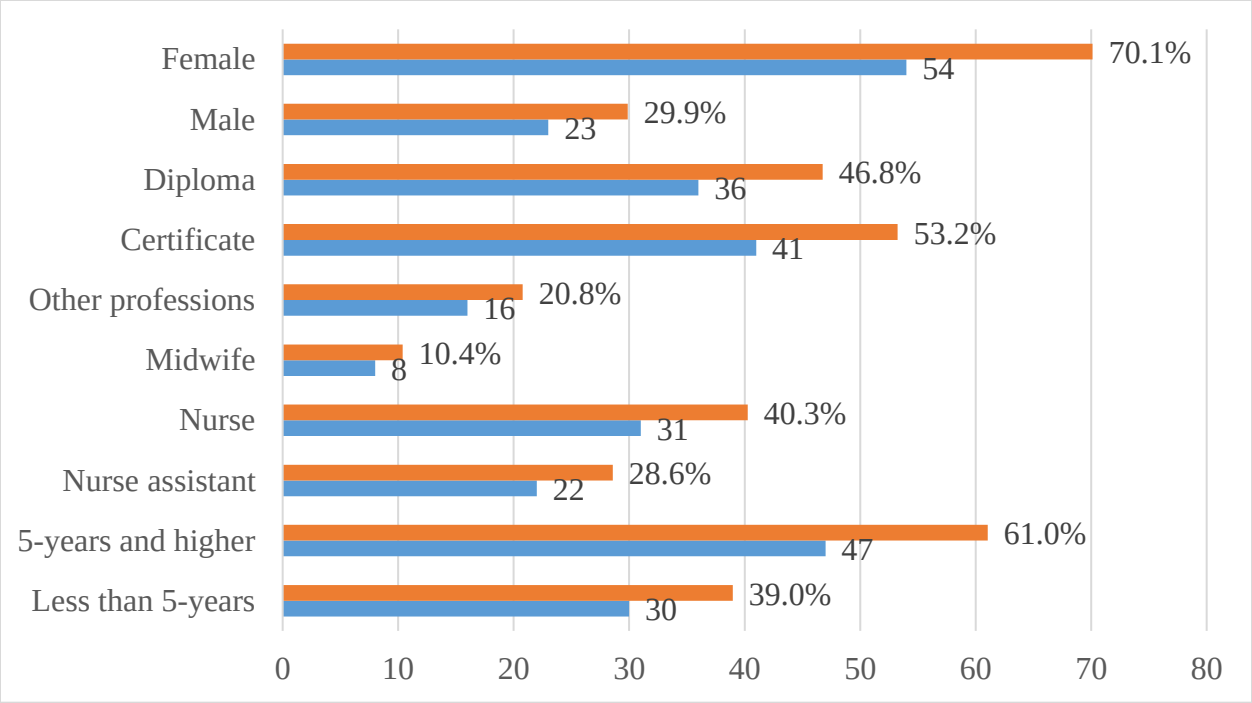

Figure 4.1. 1 Demographic characteristics of participants of the study

Figure 4.1.2 below, indicates model of CCE available for immunization services provision, with most facilities using Dometic refrigerators 42 (55%) model RCW50EG, followed by Qingdao Haier Biomedical refrigerator 26 (34%), Model HTC-110 SDD. Other models are as indicated in the Figure below. However, some refrigerators 4 (5%) were identified as UNICEF-WHO PQS qualified for use to store routine childhood vaccines. The figure also shows that most CCE 65 (84%) were functioning compared to 12 (16%) that were not functioning.

In addition, Figure 4.1.2 shows power availability for vaccine refrigerators where there were almost an equal proportion between grid electricity, and solar power while liquefied petroleum gas (LPG) as indicated in the figure. It was also observed that most facilities 50 (65%) had no alternative source of power for continuous storage of vaccines even when the main power goes off. The findings of this study were lower compared to a study conducted in Nairobi that showed 90% facilities had no backup source of power in case of power failure. [29] Absence of alternative

source of power for the CCE may create a risk for vaccine storage at facilities whenever there is power outage and overburdens healthcare workers because they have to transfer vaccines to nearby facilities for safety, and leading to missed opportunities for vaccination (MOV).

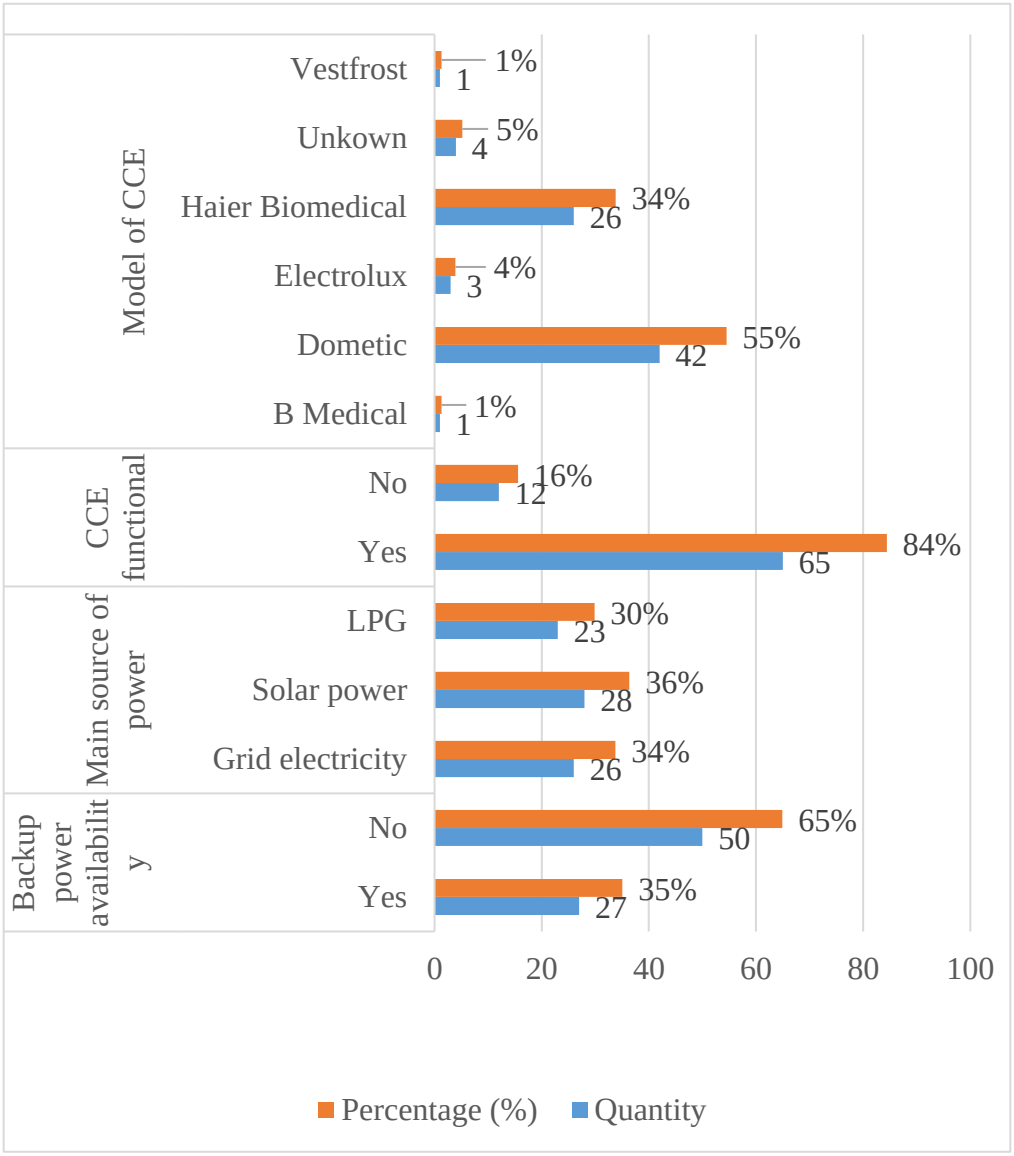

Figure 4.1. 2 CCE models, functionality, alternative and main source of power for vaccine storage refrigerators

4.2 Results based on Research Questions (RQs) for this study

This sub-section highlights the findings from study participants as they responded to four research questions mentioned in Chapter 1 above, concerning storage temperature of vaccines, stock availability, calculated opened vial wastage levels and the level of knowledge and practice of health workers during handling processes.

4.2.1 The storage temperature of vaccines at public health facilities

Data collected during this study showed that, most facilities 72 (93.5%) had their refrigerators working within WHO recommended temperature range of between +2°C to +8°C, with the mean temperature of 5.76°C. It was also found that 5 (6.5%) facilities recorded a temperature of between +9°C to 18°C during the day of data collection. However, no vaccinating facility in the study area reported a storage temperature record of below +2°C. The Figure 4.2.1.1 below shows the temperature variation among facilities in the study area.

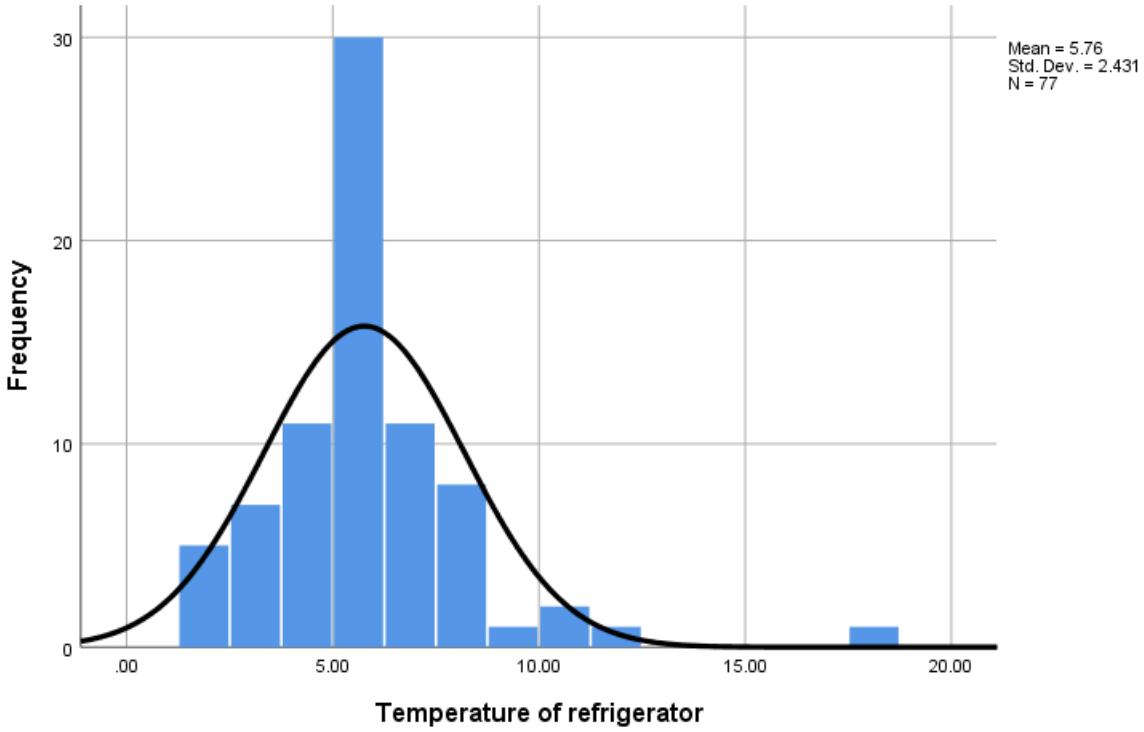

Figure 4.2.1. 1 Proportion of facilities with their respective temperature records (*n = 77*)

One of the evidence of effective temperature monitoring at health facilities is the correctly reading and filling-in the temperature charts available at health facilities. Of the facilities visited, it was observed that, 50 (64.9%) of health workers correctly filled-in temperature charts and 15 (19.5%) workers incorrectly filled in the temperature data at a standard error (SE) of 0.455. In addition, data from 12 (15.6%) facilities were not available for analysis as health workers did not record temperature readings in the temperature charts. No specific reason was provided for this omission by healthcare workers.

It was further reported that 27 (35.1%) temperature charts/data were not available for review during the study period. This practice was against the national guideline which mandates twice-daily readining and recording of the storage temperature of the vaccine refrigerator to ensure that recommended temperatures are maintained for vaccine potency assurance. The observed challenge

creates a risk of vaccine potency and may cause wastages as freezing and VVM changes may be happening and be unnoticed by vaccine handlers. Figure 4.2.1.2 below provides the summary of findings from the study.

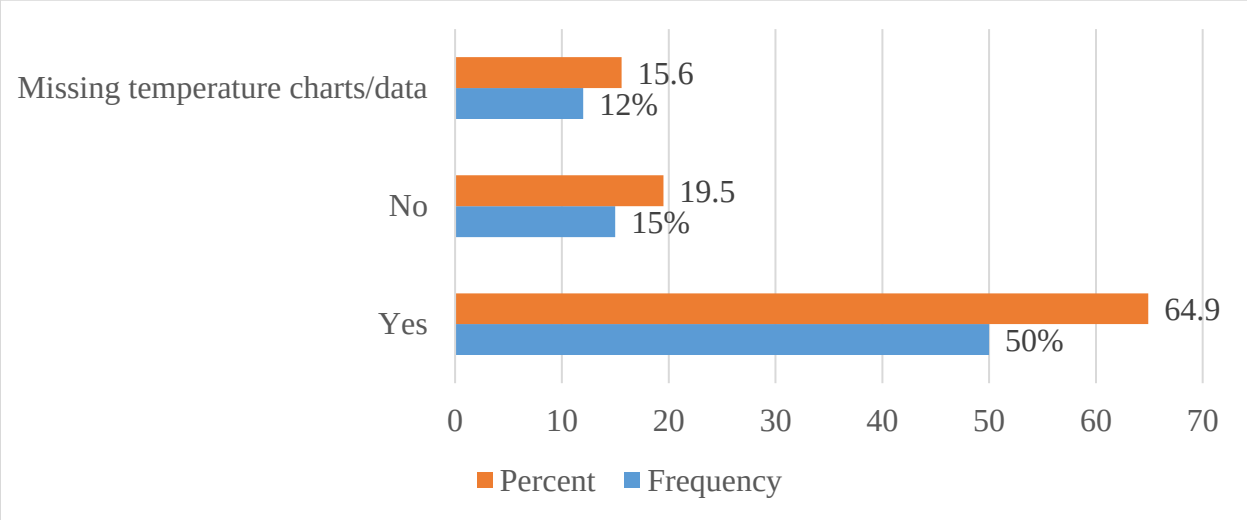

Figure 4.2.1. 2 Temperature monitoring chart correctly filled until day of visit

In addition, the researcher downloaded temperature data from Berlinger Fridge-tag® 2, a WHO prequalified 30-DTR devices found at eight (8) randomly sampled health facilities. It was found that facilities recorded a total of 38,851 (6%) minutes of temperature exposure beyond +8ºC and twenty-two (22) high temperature alarms for about 15,743 minutes from 14th September 2021 to 12th November 2021. However, these temperature exposures beyond +8ºC (that didn't trigger an alarm on the 30DTR devices) or their duration of exposure were not recorded by the vaccinators/vaccine handlers in the temperature charts. This weakness in the system may indicate underutilization of the 30DTR devices available at health facilities or inadequate level of knowledge and skills by vaccinators in using them. In addition, since district and region managers supervise these facilities on a quarterly basis it is high time to assess the level of their competency

in effective vaccine management processes. The Figure 4.2.1.2 below shows duration of exposure of vaccines during the study period at different facilities.

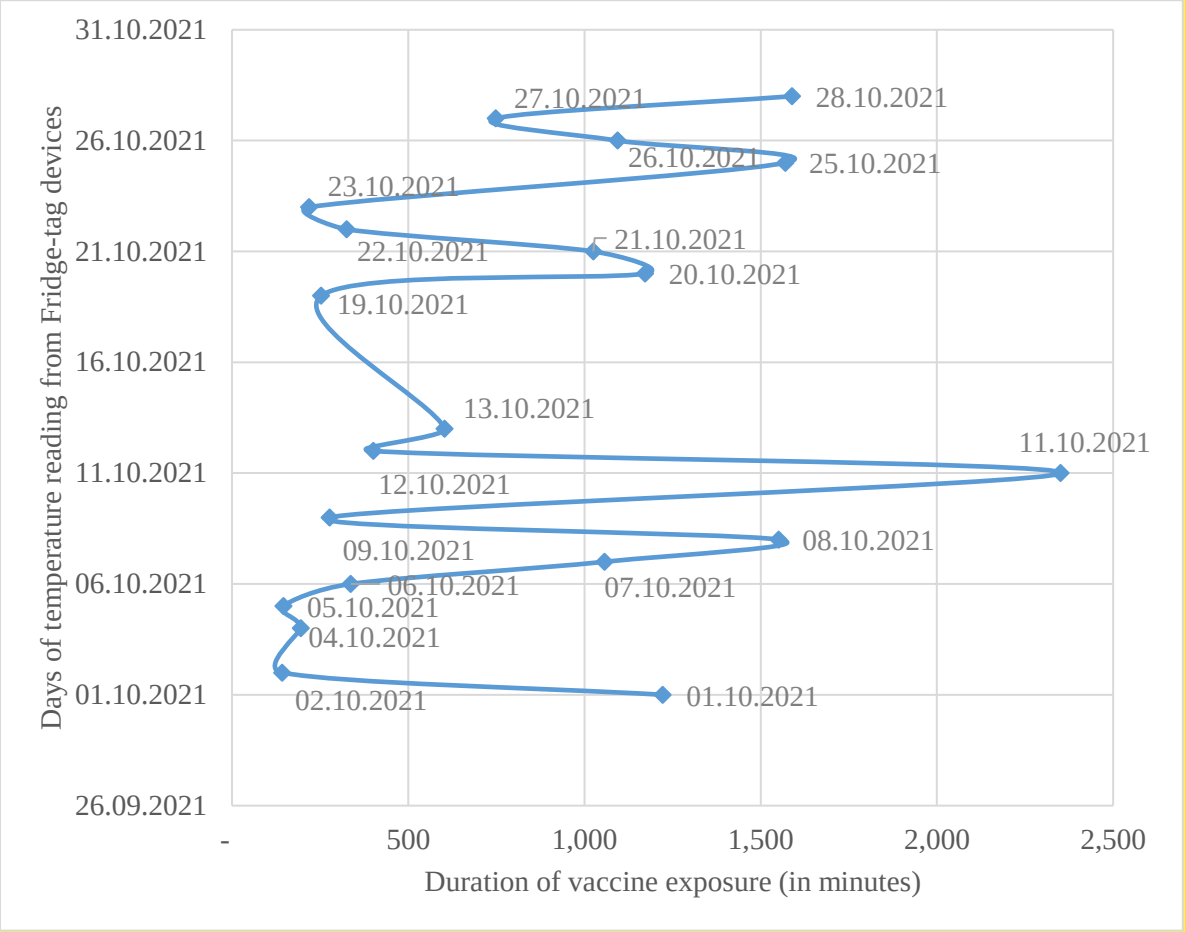

Figure 4.2.1. 3 Cumulative time exposure of vaccines in refrigerators

The above extracted data from 30DTR devices, shows exposure time of vaccines in a refrigerator as well as respective exposure temperatures within WHO recommended ranges, and any excursions beyond these ranges.

4.2.2 Status of vaccine stock availability at health facilities

This study was also structured to identify vaccine availability at health facilities in the study area. The vaccines targeted for this study were BCG, MR, DTP-HepB-Hib, and Rotavirus for children vaccination and Sinopharm for adults' vaccination.

Findings from this study show that various childhood vaccines were available at health facilities in different proportions based on their different consumption levels. In addition, facilities reported presence of other non-childhood vaccines including COVID-19 vaccines and non-vaccine commodities mainly Oxytocin.

This study found that, facilities had varying amount of vaccines. Vaccine stock out was experienced among 10 (12.9%) to 12 (15.6%) facilities for at least one antigen. In addition, 4 (5.1%) facilities experienced vaccine stock out for all five antigens under observation, for the time covered during this study. All vaccines selected for inclusion into this study experienced a stock-out status at one point during the data collection period. However, for the same vaccines the maximum stock levels ranged between 200 doses to 730 doses for Rotavirus and Pentavalent vaccines, respectively.

Table 4.2.2. 1Types and quantities of vaccine doses available at health facilities

	BCG	Rotavirus	DTP-HepB-Hib	MR	Sinopharm
N	77	77	77	77	77
Mean	95.9	46.2	73.8	62.3	47.9
Median	60	40	70	60	36
Mode	60	0[a]	70	0	0
Std. Deviation	113	50.477	88.547	54.5	48.611

Minimum	0	0	0	0	0
Maximum	660	200	730	300	250

a. Multiple modes exist. The smallest value is shown

4.2.3 Wastage rate of routine childhood vaccines available at health facilities

Immunization services is highly affected by uncontrolled high vaccine wastage rates at health facilities. This study monitored opened vial wastage rate of three (3) routine vaccines available at health facilities including DTP-HepB-Hib, Measles-Rubella (MR) and Rotavirus vaccines that were used for children immunization.

Upon calculation using the proposed formula that was developed by the WHO, this study found that, the average calculated vaccine wastage rate of DTP vaccine was seven percent for the past six months between March – August 2021 as indicated in the Table 4.2.3.1 below. In addition, the researchers calculated the average vaccine wastage rate of Measles-Rubella vaccine (MR) and found it to be 19%, while that of Rotavirus vaccine (RV) to be 15%, during the same period.

Table 4.2.3. 1 Calculated average wastage rates of DTP, Measles-Rubella and Rota vaccines

No	Name of district	Opened DTP doses	Number of children vaccinated	Calculated facility wastage rate (%)	Opened MR doses	Number of children vaccinated	Calculated facility wastage rate (%)	Opened Rota doses	Number of children vaccinated	Calculated facility wastage rate (%)
1	Malinyi district	12,530	11,584	7.5	7,770	6,311	18.8	8,139	6,964	14.4
2	Morogoro district	17,920	16,774	6.4	13,000	10,515	19.1	11,870	10,133	14.6
3	Gairo district	17,320	15,859	8.4	11,320	9,091	19.7	11,258	9,513	15.5
	Average vaccine wastage rate in the study area	**47,770**	**44,217**	**7%**	**32,090**	**25,917**	**19%**	**31,267**	**26,610**	**15%**

4.2.4 Knowledge and practice of healthcare workers with respect to vaccine management

This study found that majority of vaccinators 70 (91%) correctly mentioned the recommended storage temperatures of vaccines at health facilities. However, there were 7 (9%) vaccinators who didn't mention the correct recommended temperature range as indicated in Figure 4.2.4.1 below. Failure of healthcare workers not understand the recommended storage temperature may pose a risk of vaccine wastage as appropriate excursion response actions won't be implemented and hence create losses at health facilities and country in general.

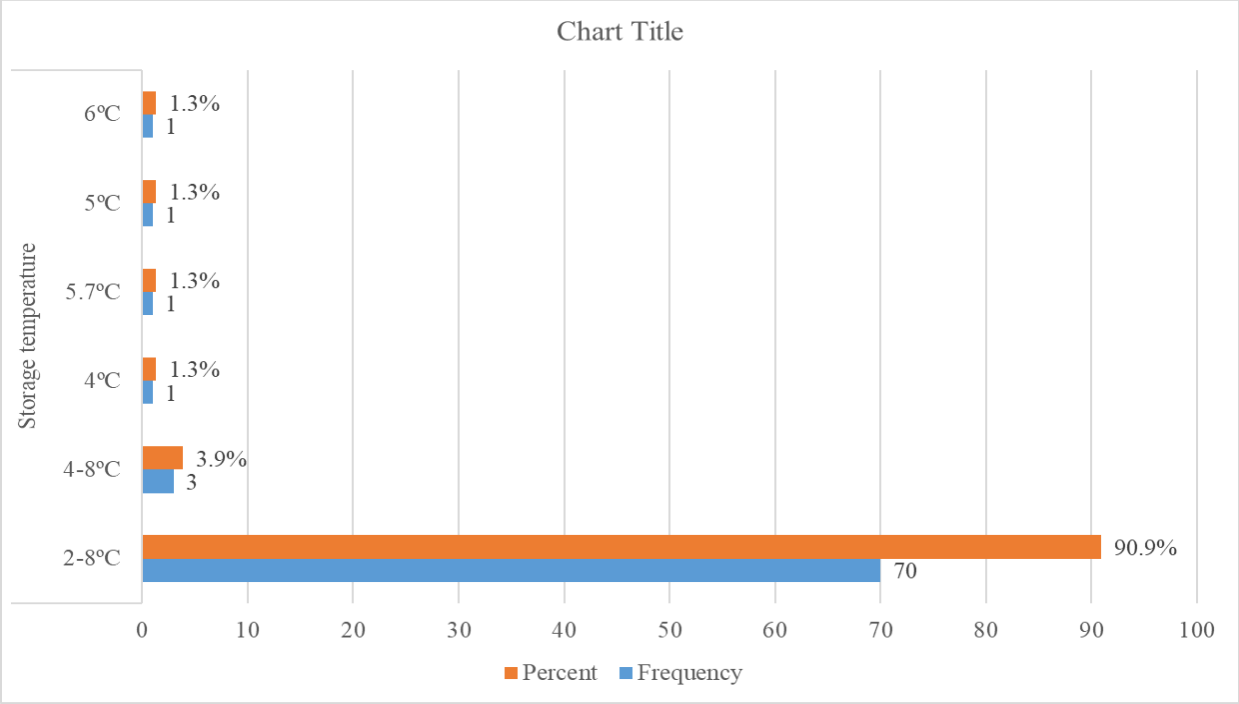

Figure 4.2.4. 1 Health workers' knowledge about WHO recommended storage temperatures of vaccine (*n = 77*)

This study also assessed the ability of health workers to use electronic device or tools so they can take necessary actions whenever needed to minimize wastages. The study found that, 58 (75%) health workers correctly knew how to read and record the current temperature of vaccine

refrigerators from the Fridge-tag® 2 device. In addition, it was reported that, 55 (71%) and 51 (66%) health workers correctly read the maximum and minimum storage temperature of vaccines at refrigerators, respectively as compared to 22 (29%) and 26 (34.0%) who respectively, were not capable to read the devices for the same.

This study further reported that, 38 (49%) healthcare workers were reviewing temperature records of their CCE, compared to 39 (51%) who did not review their temperature records as shown in Figure 4.2.4.2 below.

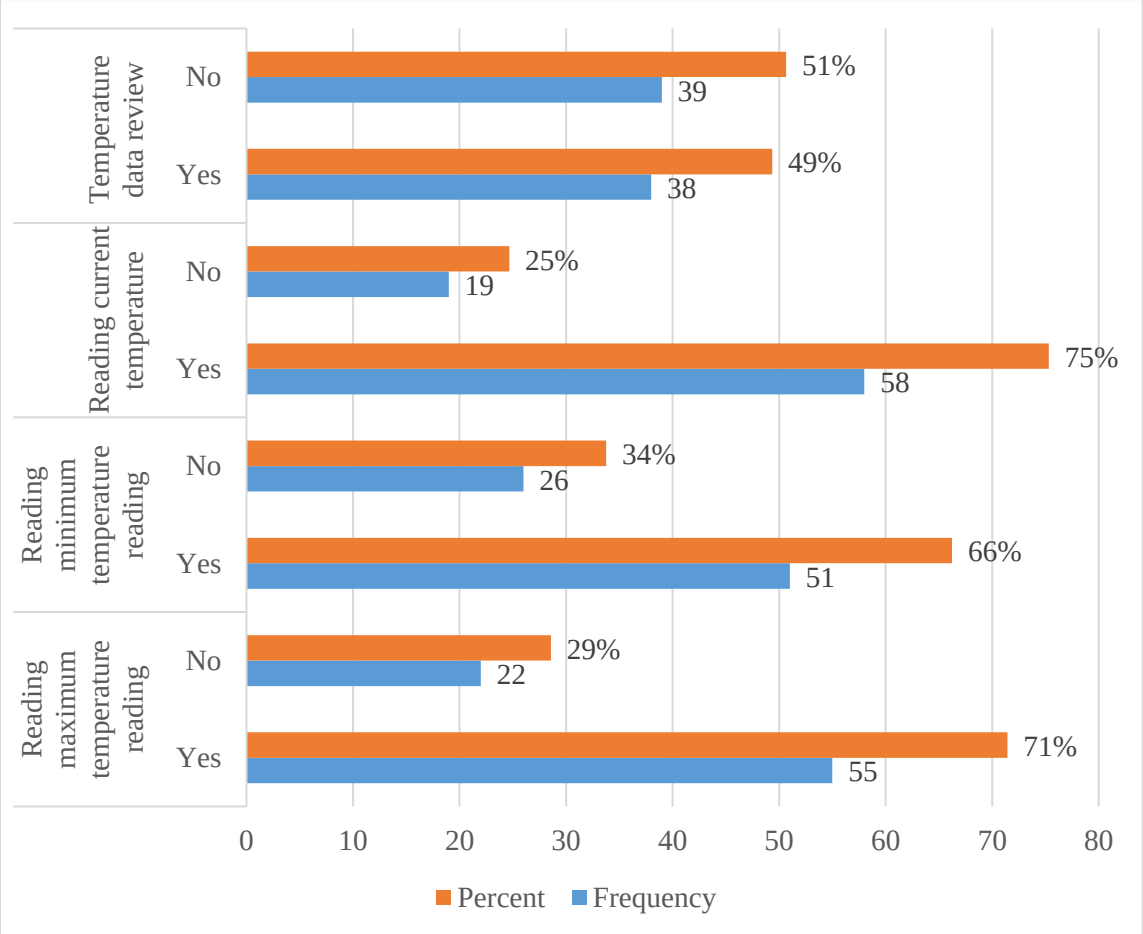

Figure 4.2.4. 2 Ability of health workers to read current, maximum and minimum temperature records from Fridge-tag devices and review temperature data

Additionally, HCWs were also requested to mention the functions of a VVM stickers that are attached on labels of vaccine vials. The responses in Figure 4.2.4.3 were collected from respondents of this study where majority 63 (81.8%) of vaccinators mentioned safety and quality monitoring as the key functions of VVM sticker, while collectively 14 (18.2%) vaccinators mentioned other functions.

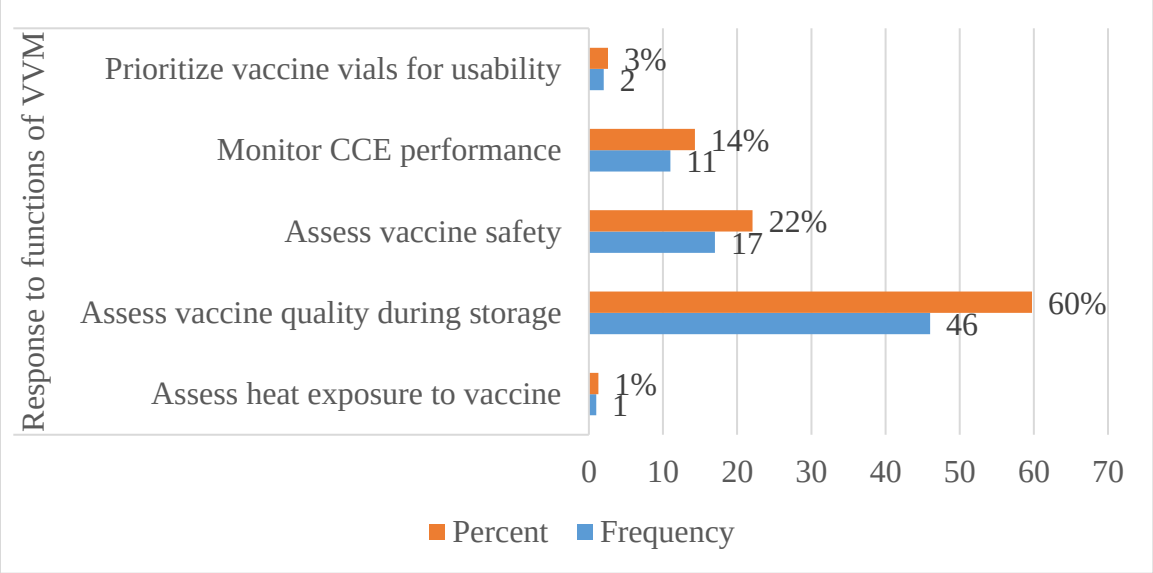

Figure 4.2.4. 3 Reported functions of Vaccine Vial Monitor (VVM) stickers

It is essential that health workers understand vaccines that are affected by freezing temperatures during storage so as to appropriately take care of the vaccines and minimize wastages at health facilities.

Concerning vaccines that are easily affected by freezing temperature, the first, second and third most reported vaccines were TT/Td, PCV-13 valent, and DTP-HepB-Hib with 30%, 44%, and 74%, respectively. Other vaccines and their position are summarized on Fig. 4.2.4.4 below.

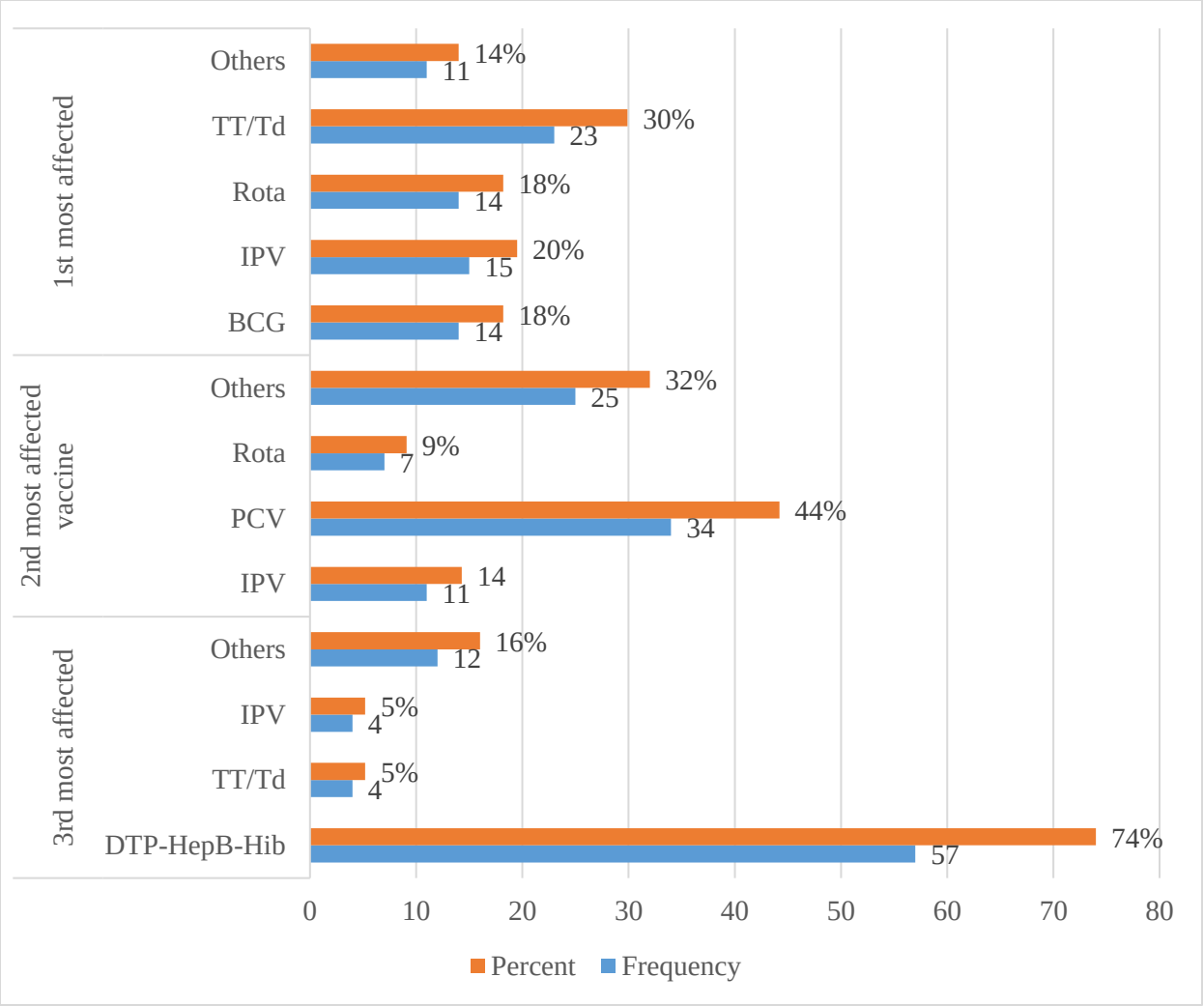

Figure 4.2.4. 4 Healthcare workers knowledge on freeze sensitivity of vaccines available at health facilities

Inferential statistics use random sample of data taken from a population to describe and make inferences about the population [43]. Inferential statistical analysis infers properties of a population, for example by testing hypotheses and deriving estimates with hypotheses testing being that allows researchers to draw conclusions about an entire population based on a representative sample [43, 44].

Table 4.2.4. 1 Model Summary b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.830[a]	0.689	0.669	2.512

a. Predictors: (Constant), Healthcare workers' training on vaccination, vaccine handling and cold chain equipment management; Ability of the healthcare provider to correctly read temperature alarm records in the temperature monitoring devices (30DTR); Presence of an alternative source of power for the vaccine storage refrigerator.

b. Dependent Variable: Presence of Human Papilloma Virus (HPV) vaccines at the facility

From the table above, R square is 0.689, in this case the Null hypothesis H_0 is accepted.

The regression analysis showed that two variables had more impact on vaccine wastage during storage at health facilities. Those variables were the number of health facilities whose healthcare workers correctly read high temperature alarm records from the Fridge-tag® 2 device (with significance level of 0.614) and of health facilities with alternative (back-up) source of power for vaccine refrigerator (with significance level of 0.763).

The Coefficients **Table** (4.2.4.2) below, indicates that the standardized Beta coefficients for X_1, X_2, and X_3 were 0.827, 0.066, and -0.037, respectively. These findings indicated that, for every 1-unit increase in X_1, the Y (vaccine wastage) variable increased by 0.868. In additional, for every 1-unit increase in X_2, the Y variable increased by 0.066; while for every 1-unit increase in X_3, the Y variable decreased by 0.037 (since the beta coefficient is negative).

Table 4.2.4. 2 Table of coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	**-8.02**	**1.682**		**-4.77**	**0**	**-11.409**	**-4.635**
HCWs trained on vaccination, vaccine handling and cold chain management	8.306	0.868	0.827	9.572	0	6.558	10.053
Vaccinators correctly reading the Maximum recorded temperature on the Fridge-tag devices	0.815	1.052	0.066	0.774	0.44	-1.305	2.935
Presence of backup/ alternative source of power for the vaccine refrigerator	-0.33	0.77	-0.037	-0.43	0.67	-1.884	1.22

a. Dependent Variable: HPV vaccine

Recalling the model, $Y=aX_1+bX_2+cX_3+e$; where by a, b, and c are the Beta coefficients

X_1 = HCWs training on vaccination, vaccine handling and cold chain management

X_2 = Vaccinators correctly reading the maximum recorded temperature on the Fridge-tag, and

X_3 = Availability of a backup/alternative source of power for the vaccine refrigerator.

CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

The discussion of study results focuses on research questions designed to respond to specific objectives. The questions based on storage temperatures monitoring performance at health facilities, vaccine stock availability and wastage monitoring, knowledge and skills of health workers in managing the vaccines and their perception towards the management process. The chapter further provides recommendations and conclusion based on the study findings obtained.

5.1 Discussion

Cold chain equipment (CCE) functionality is essential for vaccine management at health facilities and also used to extend the shelf life of these thermos-sensitive products during storage. The observed CCE functionality in the study area was found to be similar to the study conducted in Amhara, Ethiopia [10]. Availability of non-functional CCE indicate lack of planned preventive maintenance and immediate response following fault detection by the healthcare workers and cold chain technicians. It was also reported that, a high number of functional CCE was attributed by presence of the Gavi, Cold Chain Equipment Optimization Platform (CCEOP I&II) projects, phases I and II that supplied and commissioned new refrigerators to selected facilities so as to improve equitable immunization update in all communities. However, findings from this study concerning CCE functionality were slightly lower from the findings of another study conducted in Southern Nigeria [23]. This study reported most refrigerators were functioning within WHO recommended temperature range of +2°C to +8°C, and with the mean storage temperature of 5.76°C which is best range for most vaccines at health facility level. However, a few facilities (6.5%) reported a temperature performance of 9°C to 18°C which is beyond the maximum recommended temperature limit. This result indicated that, most facilities were facing a high

temperature exposure during storage. This exposure may result to changing of the VVM stickers and hence increase vaccine wastage at health facilities whenever there is oversupply of commodities or poor knowledge and skills of vaccine management among healthcare workers. This challenge may become worse because the study also reported only about one-third of facilities had back-up power supply for the CCE. This data was backed by observation of a temperature exposure of stored vaccines to more than thirty-three (33) hours consecutively. Various studies proposed that lack of alternative power (back-up energy) influences vaccine exposure to extreme temperatures and hence increase vaccine wastage due to change of VVM. [45]

Findings of this study indicated that most refrigerators that were used to store vaccines were performing better compared to a study conducted in Ethiopia [10] which reported that only 58%, facilities managed their vaccine suitably. In addition, the vaccine assessment in Tunisia reported that 60% of storage refrigerators recorded negative temperature excursions [28] contrary to findings from this study which did not report any negative temperature readings. During this study, no facility was observed with a vaccine vial with VVM sticker beyond the discard point. This observation was contrary to other studies conducted in Nigeria [23], and Ethiopia [10] which reported facilities with poor vaccine vial monitor condition of 33% and 33.4%, respectively.

However, during this study only 18% healthcare workers had a good understanding of functions of VVM in vaccine management. With this gap in knowledge on VVM use, it was indicated that effective vaccine management by using VVM sticker is still a challenge in the study area.

It is essential that immunization programmes all over the world establish strategies to ensure a continuous and uninterrupted availability of vaccines and related immunization supplies down to vaccination points. If supplies are interrupted for whatever reasons, missed opportunities to

vaccination (MOV) will be experienced by health facilities leading to the risk communities lacking protection against deadly vaccine preventable diseases. [46]

This study reported that 5% facilities were stocked out of all vaccines targeted for children and up to 17% were stocked out for at least one antigen provided in the routine immunization. The findings of this study slightly differed from a study conducted in Nairobi that reported only 10% of facilities had not experienced stock-outs for Tetanus, 9% for Measles-Rubella and 7% for Oral Polio vaccines, with DPT-HepB-Hib had the shortest duration of stock-outs lasting less than seven days at 32%. [29] If vaccinating facilities are missing any antigen that indicates that target children for immunization are missing immunization services and hence not protected. In addition, the national immunization program policy recommends that all facilities must have 50% safety stock at all times to improve vaccine availability and to improve service provision. So lack of vaccines at health facilities is against the national policy for immunization service delivery, and has been reported to influence a significant drop-out of the national DTP3 coverage levels and thus create large segments of unprotected children.

A review of stock availability in African countries reported deficiency in trained healthcare workers, poor supply chain system, delays in deliveries to health facilities, and inadequate stock management system being the most common reasons for vaccine stock-outs. [32] This study did not go deeper to identify reasons for observed vaccine stock out at health facilities.

Various studies in the Africa and the world mention weaknesses in the cold chain management challenges which influence vaccine wastages including low knowledge among health providers [10], [13], [14] breakdown of the cold chain systems [10], [11] & [13], power interruption, quality of refrigerators, etc [13]. Findings from this study reported average wastage rates of DTP, MR and

Rotavirus vaccines to be 7%, 19% and 15%, respectively. The calculated wastage rate of DTP vaccine was observed to be within the recommended national wastage range of less than 10%. In addition, it was observed that the wastage rate for MR vaccine is slightly higher by 1% compared to the national levels, however Rotavirus vaccine had a very higher wastage rate compared to the national level of 5%. These findings were however found to be lower than other studies including that conducted in India [36] which reported wastage of DTP to be 32.1% and 25.4%, and MR to be 32.2% and 21.7%, for Kangra and Pune district respectively.

Since the wastages were based on services provision, findings shown that Rotavirus vaccine wastage might be associated with operational challenges in the vaccine management by healthcare workers. Specific reasons need to be identified by health facilities as stipulated in the national vaccine management policy and strategies to minimize wastages be incorporated by every facility. If not managed well, the country will be experiencing excess wastages leading to loss of funds and missed opportunities to immunization (MOV) by children who will be visiting facilities. Unprotected children in every community pose a risk for vaccine preventable diseases outbreaks.

Despite most (89.6%) health workers reporting being supervised within the last six (6) months by the district, region or national officials, and most (90.9%) of them knowing the WHO recommended temperature storage range, still they were not able to properly document daily temperature records, and not performing temperature reviews after data compilation.

Failure of healthcare workers to read and record current, maximum and minimum temperature during storage doesn't allow health workers to foresee the risks of vaccines to damage by freezing or high temperature exposures. Maximum and minimum temperature records provides extremes of temperature exposure to vaccines even if the refrigerator functions normally in the morning and

evening when the healthcare workers are taking readings. Adequate knowledge and skills on temperature monitoring allows healthcare workers to review facility temperature data, and establish temperature response actions to avoid and/or minimize vaccine wastages during storage. In addition, review and recording of these temperature data allows health workers to understand extreme exposure of vaccines to either freezing or high temperatures and thus allows healthcare workers to establish mechanisms or strategies to rescue vaccines from temperature damage even before temperature excursions is recorded by the 30DTR devices installed in refrigerators.

5.2 Study limitations

The findings of this study have been seen in light of some limitations. Firstly, there were limited access to stock data from some healthcare facilities due to inconsistencies in availability of tools for primary data source for vaccine stock records. However, the researchers decided to incorporate the electronic system for vaccination and vaccine stock management system that was available at the district offices which delivered vaccine stocks and immunization related supplies to health facilities. Secondly, this study was affected by the outbreak of COVID-19 pandemic in the study area making it difficult to find healthcare workers at their facilities because they were engaged with outreach vaccination sessions in the communities. With this challenge, the researchers had to extend data collection time in some facilities to ensure that appropriate people are interviewed to obtain data.

5.3 Conclusion

In general, the findings of this study indicate that there were knowledge gaps among healthcare workers in managing the cold chain and vaccines at vaccinating facilities. The reported gaps included incorrectly filling of temperature charts and/or filling of wrong temperature data because of inadequate knowledge among them.

Some facilities in the study area experienced vaccine stock out for at least one antigen and for all five antigens under observation. Given the recommendation as per the national vaccination policy to ensure access and utilization of immunization services, every facility was requested to maintain a 50% or two-weeks buffer stock of vaccines at all times. The reported stock outs of vaccines would indicate that safety stock levels have been depleted and that vaccine availability could be compromised and lead to outbreaks of vaccine preventable diseases.

In addition, the researchers calculated the average vaccine wastage rates for DTP-HepB-Hib, Measles-Rubella vaccine (MR) and Rotavirus (RV) vaccines. It is essential that healthcare providers monitor vaccine wastages and document various reasons so that interventions can be instituted to minimize observed levels. The national immunization policy mandates monthly monitoring of vaccine wastages at all levels and establish thereafter establish strategies to minimize wastages without compromising vaccination of clients at all communities. Findings of this study further indicated that wastage of vaccines in unopened vials of DTP-HepB-Hib, and Measles-Rubella (MR) vaccines were within national limits and thus may be considered acceptable.

5.4 Recommendations

Storage temperature data reported by this study indicated weaknesses in the vaccine storage at health facilities causing exposure to high temperatures. However, this study did not report any exposure to freezing temperature and hence we recommend use of longitudinal study using remote temperature monitoring devices in the future and also detect vaccine wastages due to other reasons including expiration, breakages etc.

To maintain effective cold chain management further administrative efforts including training of healthcare providers are compulsory to improve the knowledge and skills reported by this study. District Health Management authorities should ensure that necessary efforts are made to ensure vaccine wastage data are routinely captured and evaluated at each facility using data quality self-assessment (DQSA). In addition, health facilities should establish and monitor data on vaccine wastage because of its importance in vaccine forecasting, and decision making towards introduction of new and more expensive vaccines, and ensure stock availability at all communities. In addition, a longer period of wastage monitoring should be established to detect wastages due to other reasons including expiration and breakages.

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LIST OF APPENDICES

Appendix 1: List of the facilities

S/No	Region	District name	Health facility name
1	Morogoro	Gairo DC	Chagongwe
2	Morogoro	Gairo DC	Chakwale
3	Morogoro	Gairo DC	Chanjale
4	Morogoro	Gairo DC	Chogwali
5	Morogoro	Gairo DC	Gairo Health Center
6	Morogoro	Gairo DC	Ibuti
7	Morogoro	Gairo DC	Idibo
8	Morogoro	Gairo DC	Ijava
9	Morogoro	Gairo DC	Iyogwe
10	Morogoro	Gairo DC	Kibedya
11	Morogoro	Gairo DC	Kisitwi
12	Morogoro	Gairo DC	Kumbulu
13	Morogoro	Gairo DC	Kwipipa
14	Morogoro	Gairo DC	Leshata
15	Morogoro	Gairo DC	Madege
16	Morogoro	Gairo DC	Makuyu
17	Morogoro	Gairo DC	Mandege
18	Morogoro	Gairo DC	Masenge
19	Morogoro	Gairo DC	Meshugi
20	Morogoro	Gairo DC	Mkobwe
21	Morogoro	Gairo DC	Msingisi
22	Morogoro	Gairo DC	Mtega
23	Morogoro	Gairo DC	Ndogomi
24	Morogoro	Gairo DC	Nguyami
25	Morogoro	Gairo DC	Nongwe
26	Morogoro	Gairo DC	Rubeho
27	Morogoro	Gairo DC	Songambele
28	Morogoro	Malinyi DC	Biro Mission Dispensary
29	Morogoro	Malinyi DC	Igawa Dispensary
30	Morogoro	Malinyi DC	Ihowanja Dispensary
31	Morogoro	Malinyi DC	Itete Dispensary
32	Morogoro	Malinyi DC	Kalengakero Mission Dispensary
33	Morogoro	Malinyi DC	Kiswago Dispensary
34	Morogoro	Malinyi DC	Lugala Lutheran Hospital

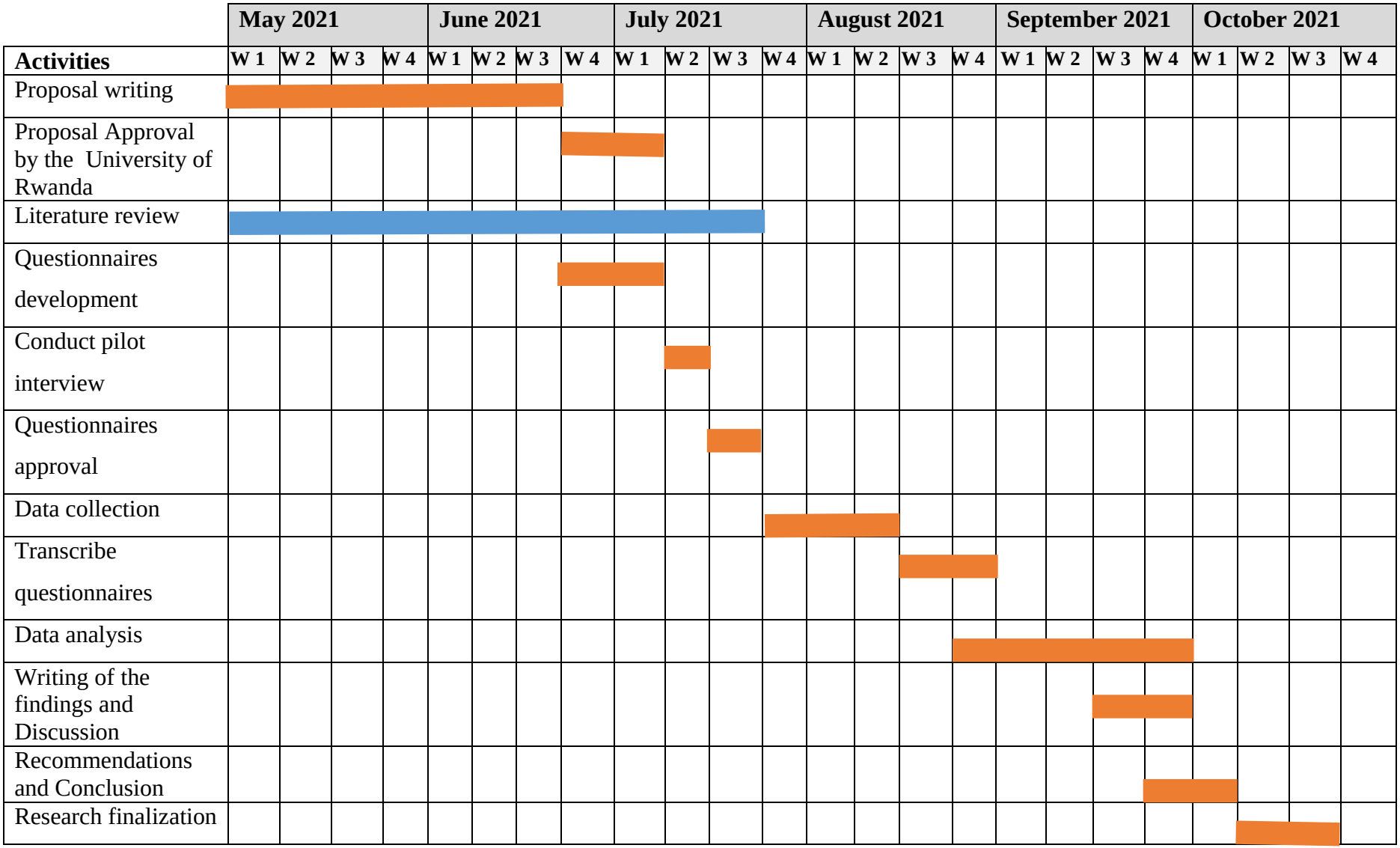
35	Morogoro	Malinyi DC	Malinyi Dispensary
36	Morogoro	Malinyi DC	Mtimbira Health Centre
37	Morogoro	Malinyi DC	Sofi Majiji Dispensary
38	Morogoro	Malinyi DC	Tanga Dispensary
39	Morogoro	Morogoro DC	Bungu
40	Morogoro	Morogoro DC	Bwakira Chini
41	Morogoro	Morogoro DC	Bwakwira Juu
42	Morogoro	Morogoro DC	Changa
43	Morogoro	Morogoro DC	Diguzi
44	Morogoro	Morogoro DC	Duthumi
45	Morogoro	Morogoro DC	Fulwe
46	Morogoro	Morogoro DC	Kalundwa
47	Morogoro	Morogoro DC	Kasanga Mission
48	Morogoro	Morogoro DC	Kibogwa
49	Morogoro	Morogoro DC	Kibungo chini
50	Morogoro	Morogoro DC	Kibungo Juu
51	Morogoro	Morogoro DC	Kidunda
52	Morogoro	Morogoro DC	Kiganila
53	Morogoro	Morogoro DC	Kikundi
54	Morogoro	Morogoro DC	Kinole
55	Morogoro	Morogoro DC	Kinonko
56	Morogoro	Morogoro DC	Kiroka
57	Morogoro	Morogoro DC	Kisaki Gomero
58	Morogoro	Morogoro DC	Kisaki Kituoni
59	Morogoro	Morogoro DC	Kisemu
60	Morogoro	Morogoro DC	Kiwege
61	Morogoro	Morogoro DC	Kizinga
62	Morogoro	Morogoro DC	Kizuka JWTZ
63	Morogoro	Morogoro DC	Kolero
64	Morogoro	Morogoro DC	Kongwa
65	Morogoro	Morogoro DC	Kungwe
66	Morogoro	Morogoro DC	Lukange Mission
67	Morogoro	Morogoro DC	Lumbachini
68	Morogoro	Morogoro DC	Lundi
69	Morogoro	Morogoro DC	Magogoni
70	Morogoro	Morogoro DC	Matombo Mission
71	Morogoro	Morogoro DC	Matuli
72	Morogoro	Morogoro DC	Mfumbwe
73	Morogoro	Morogoro DC	Mifulu
74	Morogoro	Morogoro DC	Mikese

75	Morogoro	Morogoro DC	Mkambarani
76	Morogoro	Morogoro DC	Mkuyuni
77	Morogoro	Morogoro DC	Mlilingwa
78	Morogoro	Morogoro DC	Mngazi
79	Morogoro	Morogoro DC	Msonge
80	Morogoro	Morogoro DC	Mtego Wa Simba
81	Morogoro	Morogoro DC	Mtombozi
82	Morogoro	Morogoro DC	Mvuha
83	Morogoro	Morogoro DC	Ngerengere
84	Morogoro	Morogoro DC	Nyarutanga
85	Morogoro	Morogoro DC	Nyingwa
86	Morogoro	Morogoro DC	Pangawe JWTZ
87	Morogoro	Morogoro DC	Pangawe kijijini
88	Morogoro	Morogoro DC	Sangasanga JWTZ
89	Morogoro	Morogoro DC	Seregete B
90	Morogoro	Morogoro DC	Singisa Mission
91	Morogoro	Morogoro DC	St. Mathias
92	Morogoro	Morogoro DC	Tawa
93	Morogoro	Morogoro DC	Tegetero Mission
94	Morogoro	Morogoro DC	Tulo
95	Morogoro	Morogoro DC	Tununguo
96	Morogoro	Morogoro DC	Visaraka

Appendix 2: Resources and proposed costs for the research

S/N	Activities	Costs (TZS)
1	Proposal development (stationaries, internet, printing)	280,000.00
2	Assistant data collectors (3 persons) allowance @TZS 300,000.00	900,000.00
3	Transport costs (data collection) @300,000 for 3 persons	200,000.00
4	Data collection process	600,000.00
5	Data analysis and consultancy	400,000.00
6	Report writing (stationaries, printing and internet services)	300,000.00
7	Travel and living costs (during report defending)	1,400,000.00
8	Final dissertation (printing and binding)	500,000.00
9	Research publication and findings dissemination	1,500,000.00
10	Communications	200,000.00
	Sub-total costs (TZS)	**6,280,000.00**
11	Contingency (5% of the whole budget)	314,000.00
	Total costs for the Dissertation	**6,594,000.00**

Appendix 3: Activity Work Plan (Gantt chart)



Presentation and defence																								
Research approval																								
Research dissemination and publication																								

Appendix 4: Questionnaire - English

Questionnaire for *"Assessment of Vaccine Management Practices among Health Workers: A case of Public Health Facilities in Morogoro region, Tanzania"*

My name is ***NESTORY, Bonaventura (****Reg. No: 220014845)*, a student at the College of Medicine and Health Sciences, of the **University of Rwanda**. I am conducting a study on **Assessment of vaccine Management Practices among Health Workers: A case of Public Health Facilities in Morogoro region, Tanzania.**

The main objective of this study is to assess factors influencing effective vaccine management and decision-making among health workers at public health facilities in Morogoro region, Tanzania.

You have been selected to participate in this study based on your involvement in vaccine management/ as a vaccinator. I hereby, request your participation in this study by responding to the questions provided/asked. Your names and response will be confidential and all information will be used for the purpose of the study and not otherwise.

Are you willing to continue with the study? **Yes** ☐ **No** ☐

Your names: …… Signature: …….

Level of the facility: ……

Facility Code: …… **Date: ……**

S/No	QUESTIONS	RESPONSES	CODE	
1. Demographic information				
1.1	Gender of the vaccinator?	Male	1	
		Female	2	
1.2	What is the level of your education	Certificate	1	
		Diploma	2	
		Bachelor degree	3	
1.3	How long have you managed childhood vaccines??	Less than 5 years	1	
		More than 5 years	2	
1.4	What is your job title? (tick one option)	Vaccinator	1	
		Administrator (HF in-charge, etc)	2	
		Both vaccinator and administrator	3	
1.5	What is your profession?	Nurse assistant	1	
		Nurse	2	
		Midwifery	3	
		Health Officer	4	
2. General knowledge on vaccine management				
2.1	Have you received any training on vaccination, vaccine management and/or cold chain management?	Yes	1	
		No	2	
2.2	Have you received supervision on vaccination and/or cold chain management during the past one year?	Yes	1	
		No	2	
2.3	When was the last supervision conducted at your facility?	Date: (dd-mm-yyyy) ……		
2.4	What is the recommended storage temperature for routine childhood immunization vaccines at health facilities?	……		
2.5	What is the function of Vaccine Vial Monitor (VVM)?		1	
			2	
			3	
			4	
2.5			1	
			2	

	Mention at least three (3) vaccines which are affected by freezing temperatures during storage?		3	
3. Refrigerator characteristics and performance				
3.1	What is the Brand/make and model of the vaccine storage refrigerator?	Brand/make: …… Model: ……		
3.2	Read and record the available storage capacity (space) for vaccine storage?	Net storage capacity: ……... liters		
3.3	Is the refrigerator which is used to store vaccine functional?	Yes	1	
		No	2	
3.4	What is the main source of power (energy) for the vaccine refrigerator?	Electricity (*mains*)	1	
		Electricity (*Solar*)	2	
		Gas (Liquefied petroleum gas)	3	
3.5	Is there a back-up source of power (energy) for the vaccine refrigerator?	Yes	1	
		No	2	
3.6	If **YES**, mention the back-up source of energy for vaccine refrigerator	……		
4. Vaccine storage performance				
4.1	What vaccines and their respective number of doses are available in the refrigerator? *Only count unopened vials*	BCG vaccine		doses
		Pneumococcal Conjugate Vaccine (PCV-13)		doses
		Rotavirus vaccine		doses
		DTP-HepB-Hib vaccine		doses
		Inactivated Polio Vaccine (IPV)		doses
		Oral Polio Vaccine (OPV)		doses
		Tetanus diphtheriae (Td)		doses
		Measles-Rubella (MR)		doses
		Human Papilloma Vaccine (HPV)		doses
4.2	***Observe and record*** the number of cool water packs available in the vaccine carrier	Are they adequate? *The number should be four and fit inside the carrier*		
		Yes	1	
		No	2	
4.3		Are there ice packs in refrigerator?		

	Observe and record if the facility is using cool water packs or frozen ice packs during vaccination process			
		Yes	1	
		No	2	
		Are there cool water packs in refrigerator?		
		Yes	1	
		No	2	
4.4	Did you observe any vaccine vial with Vaccine Vial Monitor (VVM) in the "***Do Not Use***" stage?	Yes	1	
		No	2	
4.5	If **YES** above, mention type of vaccines and number of doses	Vaccine type: …… Number of doses: ……	1	
		Vaccine type: …… Number of doses: ……	2	
		Vaccine type: …… Number of doses: ……	3	
4.6	What did you do when your facility recorded a freezing temperature alarm?			1
				2
				3
4.7	How many doses of vaccines were discarded unopened during the past 6 months? *Check issue vouchers and vaccine ledgers, and compare with vaccinated children*		# of Doses	
		BCG vaccine		
		Pneumococcal Conjugate Vaccine (PCV-13)		
		Rotavirus vaccine		
		DTP-HepB-Hib vaccine		
		Inactivated Polio Vaccine (IPV)		
		Oral Polio Vaccine (OPV)		
		Tetanus diphtheriae (Td)		
		Measles-Rubella (MR)		
		Human Papilloma Vaccine (HPV)		
5. Temperature performance				
5.1	What is the refrigerator temperature reading during the day of visit?	……	°C	
5.2	Is the temperature monitoring chart completed, updated and correctly filled in until the day of visit?	Yes	1	
		No	2	
5.3		Yes	1	

	Is the temperature data recorded in the last month (30 days) match the data stored in electronic devices (including Fridge-tag® 2 or ColdTrace-5)?	No	2	
5.4	Does the health worker know how to read the following in the Fridge-tag® 2 device?	Current temperature	Yes	1
			No	2
		Maximum & Minimum temperatures	Yes	1
			No	2
		Temperature alarms - ***Freezing***	Yes	1
			No	2
		Temperature alarms - ***Hot***	Yes	1
			No	2
6. Temperature data use for decision-making				
6.1	Do you review of temperature data at your facility?	Yes	1	
		No	2	
6.2	What type of data did you review in the last session/meeting?		1	
			2	
			3	
			4	
6.3	After data review in the last meeting what action(s) did you take?		1	
			2	
			3	
6.4	What did/would you do when you receive SMS reminder concerning freezing alarm in your refrigerator?		1	
			2	
			3	
6.5	What did/would you do when you receive SMS reminder concerning hot temperature alarm in your refrigerator?		1	
			2	
			3	
6.7	Is there a response protocol (Standard Operating Procedure-SOP) indicating necessary actions to take when you observe temperature excursions? *Kindly observe the protocol*	Yes	1	
		No	2	
6.8	Mention performance challenges you are facing when responding to temperature alarms		1	
			2	
			3	
			4	

Appendix 5: Questionnaire - *Swahili*

Dodoso la Utafiti *"Tathmini ya Utunzaji wa Chanjo miongoni mwa Watoa huduma: Utendaji katika Vituo vya Huduma za Afya vya Serikali vilivyopo mkoani Morogoro, nchini Tanzania"*

Jina langu ni ***NESTORY, Bonaventura*** *(Namba ya Usajili: 220014845),* ambaye ni mwanafunzi wa Mwaka wa Pili wa Shule ya Afya na Utabibu katika **Chuo Kikuu cha Rwanda**.

Ninafanya utafiti wa kimasomo kuhusu **Tathmini ya Utunzaji wa Chanjo miongoni mwa Watoa Huduma: Utendaji katika Vituo vya Huduma za Afya vya Serikali vilivyopo mkoani Morogoro, nchini Tanzania.**

Lengo kuu utafiti huu ni kutathmini sababu mbalimbali zinazochochea utunzaji wa chanjo na uchukuaji wa hatua ili kuboresha huduma miongoni mwa watoa huduma katika vituo vya huduma za afya.

Umechaguliwa kushiriki kwenye utafiti huu kwa kutokana na majukumu yako ya utunzaji na/au utoaji wa huduma za chanjo katika kituo hiki. Hivyo, ninaomba uridhie na kushiriki kwenye utafiti huu ili usaidie kujibu maswali mbalimbali na kutumia uzoefu wako katika utunzaji wa chanjo ili kuboresha utendaji katika vituo vingine hapa nchini.

Majina yako na ya kituo chako hayatatumika kwenye taarifa itakayoandaliwa hapo baadaye kwa kuwa taarifa hizo ni siri baina yako na Mdodosaji. Hali kadhalika, majibu utakayotoa yatatumika kwa ajili ya malengo ya utafiti huu pekee.

Je, sasa unaridhia kushiriki kwenye utafiti huu? **Ndiyo** ☐ **Hapana** ☐

Jina lako: …… Saini: ……

Ngazi ya kituo cha huduma: ….…….……

Namba ya utambulisho: …… **Tarehe ya utafiti: ……**

Na:	MASWALI	MAJIBU	Namba	
1. Taarifa za kituo				
1.1	Jinsia ya mtoa huduma	Mwanaume	1	
		Mwanamke	2	
1.2	Je, una taaluma/fani gani?	Muuguzi Msaidizi	1	
		Muuguzi	2	
		Mkunga	3	
		Afisa Afya	4	
		Taaluma nyingine …	5	
1.3	Kiwango cha elimu yako	Cheti	1	
		Stashahada	2	
		Shahada	3	
1.4	Nafasi yako kazini ni ipi?	Mchanjaji	1	
		Kiongozi (Mkuu wa kituo, Msimamizi wa RCH, nk)	2	
		Mchanjaji na kiongozi	3	
1.5	Umefanya kazi ya utunzaji au utoaji wa chanjo kwa muda gani?	Chini ya miaka mi 5	1	
		Miaka mi 5 au zaidi	2	
2. Maswali ya uelewa kuhusu utunzaji wa chanjo				
2.1	Je, umewahi kupata mafunzo yoyote kuhusu uchanjaji, utunzaji wa chanjo, au utunzaji wa jokofu la chanjo?	Ndiyo	1	
		Hapana	2	
2.2	Je, umefanyiwa usimamizi elekezi kuhusu uchanjaji au utunzaji wa chanjo kwa kipindi cha mwaka mmoja uliopita?	Ndiyo	1	
		Hapana	2	
2.3	Je, usimamizi wa mwisho ulifanyika lini?	Tarehe: …… Mwezi: ……Mwaka: ……		
2.4	Je, inashauriwa kutunza chanjo za watoto katika ubaridi gani hapa kituoni kwako?	Nyuzijoto …… °C		
2.5	Naomba unitajie kazi za kiashiria cha halijoto za chanjo (Vaccine Vial Monitor - VVM)?		1	
			2	
			3	
			4	

2.6	Taja aina tatu za chanjo zinazoharibika kwa urahisi ikiwa zitatunzwa kwenye ubaridi mkali wa kuganda ("*freezing temperatures*")?		1	
			2	
			3	
3. Utendaji kazi wa jokofu la kutunzia chanjo				
3.1	Je, kituo kinatumia **aina** na **modeli** gani ya jokofu kwa ajili ya kutunza chanjo?	Aina: …… Modeli: ……		
3.2	Je, jokofu la kutunzia chanjo linafanya kazi kwa sasa?	Ndiyo	1	
		Hapana	2	
3.3	**Soma na kuandika** ujazo wa jokofu la kutunzia chanjo lililopo kituoni	Ujazo wa kutunza chanjo: **Lita**……		
3.4	Je, nini chanzo kikuu cha nishati kinachotumiwa na jokofu la kutunza chanjo?	Umeme wa gridi	1	
		Umeme jua	2	
		Gesi (*LPG*)	3	
3.5	Je, kuna chanzo mbadala cha nishati kwa ajili ya jokofu la kutunza chanjo?	Ndiyo	1	
		Hapana	2	
3.6	Ikiwa umejibu **NDIYO**, taja chanjo hicho cha nishati	……		
4. Utunzaji wa chanjo kituoni				
4.1	Je, kuna aina gani ya chanjo na idadi ya (dozi) zilizopo kituoni kwa sasa? *Hesabu dozi katika vichupa ambavyo havijafunguliwa tu*	BCG vaccines	Dozi	
		Pneumococcal Conjugate Vaccine (PCV-13)	Dozi	
		Rotavirus vaccine	Dozi	
		DTP-HepB-Hib vaccine	Dozi	
		Polio ya Sindano (IPV)	Dozi	
		Polio ya matone (OPV)	Dozi	
		Tetanus diphtheriae (Td)	Dozi	
		Surua-Rubella (MR)	Dozi	
		Human Papilloma Vaccine (HPV)	Dozi	
		Sinopharm COVID-19 vaccine	Dozi	
		Hepatitis B vaccine	Dozi	
		Janssen COVID-19 vaccine	Dozi	
4.2	***Angalia na kuandika*** idadi ya vibeba maji (water packs) vilivyopo ndani ya kibeba chanjo (vaccine carrier) wakati wa huduma. ***Idadi*** ……	Je, idadi inatosheleza? *Kunatakiwa kuwe na vibeba maji vi 4 vinavyokaa vyema ndani ya kibeba chanjo*		
		Ndiyo	1	
		Hapana	2	

4.3	***Angalia na kuandika*** idadi ya vibeba maji (*cool water packs*) au vibeba barafu **(***frozen ice packs*) vilivyoko ndani ya jokofu la kutunzia chanjo	Je, kuna vibeba barafu ndani ya jokofu la kutunzia chanjo?		
		Ndiyo	1	***Idadi***
		Hapana	2	
		Je, kuna vibeba maji ndani ya jokofu la kutunzia chanjo?		
		Ndiyo	1	***Idadi***
		Hapana	2	
4.4	Je, umegundua uwepo wa kichupa chochote cha chanjo kikiwa na kiashiria cha (VVM) kilichofika hatua ya mwisho wa matumizi?	Ndiyo	1	
		Hapana	2	
4.5	Ikiwa jibu ni **NDIYO** kwenye swali 4.4, taja aina na idadi ya dozi za chanjo zilizoharibika	Aina ya chanjo: ……	1	**Idadi**
		Aina ya chanjo: ……	2	**Idadi**
		Aina ya chanjo: ……	3	**Idadi**
4.6	Je, ulifanya nini ulipogundua kuwa kuna ishara ya kuganda kwenye jokofu la chanjo iliyotokana na ubaridi mkali?			1
				2
				3
				4
4.7	Je, katika kipindi cha miezi 6 iliyopita ni kiasi gani cha dozi za chanjo kimeharibika bila vichupa kufunguliwa? *Chunguza idadi kwenye "issue voucher" zilizopo, leja ya mali na kulinganisha na watoto wote waliopatiwa huduma*	**Aina ya chanjo**	**Idadi ya dozi**	
		Chanjo ya BCG		
		Chanjo ya PCV-13		
		Chanjo ya Rotavirus		
		Chanjo ya DTP-HepB-Hib		
		Chanjo ya IPV		
		Chanjo ya Polio ya matone (OPV)		
		Chanjo ya Tetanus diphtheriae (Td)		
		Chanjo ya Surua-Rubella (MR)		
		Chanjo ya HPV		
4.8	Je, ukiacha chanjo kuna bidhaa nyingine zimetunzwa ndani ya jokofu la kutunzia chanjo? *Zitaje*	**Aina**	**Idadi**	

5. Halijoto ya utunzaji wa chanjo kituoni				
5.1	Je, ubaridi wa jokofu la kutunzia chanjo ulikuwa katika kiwango gani wakati umefika kituoni? *Soma kifaa kilichopo na kuandika*	……	°C	
5.2	Je, fomu ya kufuatilia halijoto ya utunzaji wa chanjo imejazwa vizuri na kikamilifu mpaka siku ya utafiti huu? *Piga picha fomu ya halijoto na kuwasilisha*	Ndiyo	1	
		Hapana	2	
5.3	Je, taarifa ya halijoto iliyojazwa na mtoa huduma mwezi uliopita **inawiana** na taarifa zilizopo kwenye kifaa cha kielektroniki? *Chukua na kuwasilisha taarifa za kifaa cha Fridge-tag® 2 au ColdTrace-5*	Ndiyo	1	
		Hapana	2	
5.4	Je, mtoa huduma ameweza kusoma kwa usahihi taarifa zifuatazo kwenye kifaa cha kufuatilia halijoto? *Tumia taarifa za kifaa cha Fridge-tag® 2 kudodosa*	Halijoto ya sasa	Ndiyo	1
			Hapana	2
		Kiwango cha juu zaidi	Ndiyo	1
			Hapana	2
		Kiwango cha chini kabisa	Ndiyo	1
			Hapana	2
		Alamu ya **kugandisha**	Ndiyo	1
			Hapana	2
		Alamu ya **joto**	Ndiyo	1
			Hapana	2
6. Matumizi ya taarifa ya halijoto baada ya uchambuzi				
6.1	Je, kuna utaratibu wa kuchambua taarifa ya halijoto ya jokofu la chanjo?	Ndiyo	1	
		Hapana	2	
6.2	Tafadhali taja aina ya taarifa mlizochambua wakati wa kikao cha mwisho?		1	
			2	
			3	
			4	
6.3	Je, mlipanga kutekeleza mambo gani baada ya kikao cha uchambuzi wa taarifa?		1	
			2	
			3	

6.4	Je, utachukua hatua gani (*utafanya nini*) ikiwa utapokea ujumbe wa SMS kuhusu jokofu la kituo kuwa na ubaridi mkali?		1	
			2	
			3	
6.5	Je, utachukua hatua gani (*utafanya nini*) ikiwa utapokea ujumbe wa SMS kuhusu jokofu la kituo kuwa na joto kali?		1	
			2	
			3	
6.7	Je, hapa kituoni kuna mwongozo wa hatua za kuchukua ikiwa mtagundua uwepo wa ubaridi mkali kwenye jokofu la chanjo? *Kagua ili uone muongozo husika*	Ndiyo	1	
		Hapana	2	
6.8	Tafadhali taja vikwazo mnavyokutana navyo wakati wa ufuatiliaji wa halijoto za juu au za chini?		1	
			2	
			3	
			4	

Appendix 6: Research permit

JAMHURI YA MUUNGANO WA TANZANIA
OFISI YA RAIS
TAWALA ZA MIKOA NA SERIKALI ZA MITAA

Anuani ya Simu "TAMISEMI" DODOMA
Simu Na: +255 26 2321607
Nukushi: +255 26 2322116
Barua pepe:ps@tamisemi.go.tz

Mji wa Serikali – Mtumba,
Mtaa wa TAMISEMI,
S.L.P. 1923,
41185 DODOMA.

Unapojibu tafadhali taja:-

Kumb. Na. AB. 307/323/01 **23 Septemba, 2021**

Katibu Tawala wa Mkoa,
Ofisi ya Mkuu wa Mkoa,
S.L.P. 650,
MOROGORO.

Yah: **KIBALI CHA UTAFITI**

Tafadhali rejea somo tajwa hapo juu.

2. **Bw. Bonaventura Nestory** ni Mwanafunzi wa Chuo Kikuu cha Rwanda anaefanya Shahada ya Uzamili na anafanya Utafiti katika Mkoa wako Morogoro.

3. Kichwa cha habari cha Utafiti wake ni ***"Assessment of vaccine management practices mamong health workers: A case of public Health Facilities in Morogoro Region, Tanzania"*** Muda wa Kibali hiki kimetolewa kuanzia Septemba, 2021 hadi Novemba, 2021.

4. Naleta kwako ombi la **Bw. Bonaventura Nestory** kupewa ushirikiano ili kukamilisha malengo ya Utafiti huo kama matakwa ya kukamilisha Elimu yake katika shahada ya Uzamili **(Msc. Health Supply Chain Management University of Rwanda).** Katika utekelezaji wa majukumu yake anaelekezwa kufuata Sheria za Nchi, Taratibu na Miongozo iliyopo.

Ninakushukuru kwa ushirikiano wako.

Dkt. N. A. Kapologwe
Kny: **KATIBU MKUU**

Nakala: Katibu Mkuu,
Wizara ya Afya, Maendeleo ya Jamii,
Jinsia, Wazee na Watoto,
Mji wa Serikali – Mtumba,
S. L. P. 743,
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