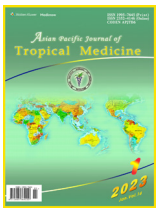

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Knowledge and associated factors of healthcare workers on measles vaccine and cold chain management at health institutions in Gondar, Ethiopia

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ABSTRACT

Objective: To assess the knowledge of healthcare workers on the measles vaccine and its cold chain management.

Method: An institutional-based cross-sectional study was conducted from February 1 to March 30, 2022 in Gondar City Administration public health institutions among 165 healthcare workers. Data were collected using a structured questionnaire. In addition, an on-spot observation checklist was used to assess the availability, status and management of the cold chain. A logistic regression model was used to assess the relationship between the outcome and predictor variables. Crude and adjusted odds ratios were calculated with 95% confidence intervals.

Results: Overall, 87 (52.7%; 95% *CI* 44.8%-60.5%) of the healthcare workers had unsatisfactory knowledge regarding the measles vaccine and its cold chain management. One hundred thirty-six (82.4%) healthcare workers correctly mentioned the recommended range of temperature (2-8 ℃) for measles vaccine storage. Healthcare workers aged 18-29 years (P=0.001) and 30-44 years (P=0.014) were observed as determinants of unsatisfactory knowledge on the measles vaccine and its cold chain management. One hundred and five (63.6%) of the healthcare workers did not correctly mention the type of measles vaccine used in routine immunization. More than one-third (36.4%) of the healthcare workers perceived that the measles vaccine is not safe and could cause measles.

Conclusions: More than half of the healthcare workers in the study area had unsatisfactory knowledge on the measles vaccine and its cold chain management. It is necessary to provide technical support and in-service training for healthcare workers to ensure optimal immunization effectiveness.

KEYWORDS: Measles vaccine; Healthcare workers; Cold chain; Gondar

1. Introduction

Vaccination is one of the most effective public health interventions available for vaccine-preventable diseases[1]. The efficacy of a vaccine in preventing disease depends largely on the quality of the immunizing agent[2]. High immunization coverage and vaccine inventory management, including proper storage and handling of vaccines, determine the success of vaccination. Hence, cold chain management and training of healthcare workers (HCWs) are

Significance

Despite considerable improvement in measles immunization coverage in Ethiopia, measles outbreaks continue to occur in most parts of the country. This study was aimed to assess the knowledge of healthcare workers on measles vaccine and its cold chain management. Majority of the study participants had unsatisfactory knowledge. The present findings may be helpful to ensure optimal measles immunization effectiveness by providing technical support and training for healthcare workers.

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essential components of a successful immunization program[3]. The World Health Organization (WHO) has developed a set of guidelines to properly manage expanded programs on immunization services in its member countries including Ethiopia.

Countries in the WHO Africa region began implementing the recommended measles control strategies in 2001[4]. In September 2011, the WHO adopted a goal of measles elimination from the African Region by the year 2020[5,6]. Ethiopia endorsed the measles elimination goal in 2012 and has implemented the recommended strategies[7]. The first dose of measles containing vaccine (MCV1) is given at the age of 9 months, with the second opportunity only available through supplementary immunization. In 2019, Ethiopia has also introduced measles containing vaccine (MCV2)[6,8]. In 2019, only 59% of children were vaccinated with MCV1, and 9% of children aged 24-35 months received MCV2 in Ethiopia[9]. The lowest proportion of full vaccination coverage including measles in Ethiopia ranged from 21% to 73%, in which the lost proportion was reported from Afar Region whereas the highest proportion was from Amhara Region[10]. Studies revealed that fear of side effects, low-income status, poor infrastructure, low health service coverage, being too busy, lack of awareness about vaccination, and poor perception toward vaccination were factors for poor immunization[10,11]. Despite considerable improvement in measles immunization coverage in Ethiopia, measles outbreaks continue to occur in most parts of the country and becoming a significant cause of under-five mortality and morbidity[12,13]. Low vaccination coverage, prevailing poor nutritional conditions, and accumulation of unvaccinated children might have contributed to the frequent measles outbreaks in different parts of the country[13]. Controlling the spread of the measles virus requires good laboratory-based surveillance strategies, rapid detection, control of periodic outbreaks, and vaccination of susceptible children[14]. Continued research on measles virus epidemiology and cold chain management is essential to offer enhanced protection and avert vaccination failures[3].

The term cold chain is used to emphasize the importance of keeping vaccines at an appropriate temperature throughout the chain of transport, storage, and administration[15,16]. Proper transport, storage and handling of vaccines are issues that are frequently overlooked when creating or implementing vaccine protocols[17]. Hence, the establishment and proper utilization of vaccine storage and handling policies are the key criteria for vaccine management and administration[18]. In addition, the use of appropriate storage equipment, maintaining correct temperatures, recording daily temperature, and taking an action in emergencies are important requirements to maintain product quality[19,20]. During transportation, proper packaging and the use of appropriate containers which can able to maintain the storage temperature must be used to prevent the deterioration of the vaccine[21].

Several reports have assessed the knowledge of HCWs on handling and cold chain management about immunization practice. Despite the poor infrastructure and limited vaccination coverage in Ethiopia, there are few studies conducted to assess the knowledge of HCWs on the proper usage of routine childhood vaccines. Therefore, this study was designed to assess the knowledge of measles vaccine and its cold chain management among HCWs in Northwest Ethiopia.

2. Subjects and methods

2.1. Study area and period

The study was conducted in public health institutions within the Gondar City Administration, Northwest Ethiopia from February 1, 2022, to March 30, 2022. Gondar City is an administrative center for the central Gondar Zone located 250 kilometers from Bahir Dar, the Capital City of the Amhara National Regional State. The Gondar city administration consists of 20 urban kebeles (administration units). The city administration has eight health centers and one Comprehensive Specialized Hospital.

2.2. Study design and population

An institutional-based cross-sectional study was carried out to assess the knowledge of health professionals. The study population was HCWs who could be engaged in handling the measles vaccine and its cold chain management.

2.3. Inclusion and exclusion criteria

Healthcare workers who are full-time employees of the health institutions at the city administration were included. Healthcare workers who do not have direct involvement in immunization and were on study leave at the time of data collection were excluded.

2.4. Sample size and sampling procedures

All healthcare workers, 165 nurses, midwiferies, physicians, health officers, pharmacies and environmental, who could be directly or indirectly engaged in handling, storage and administration of measles vaccine were included in the study. Consecutive sampling technique was used until the targeted healthcare workers were reached.

2.5. Data collection tools and procedures

Data were collected through a structured questionnaire developed from an extensive literature search. The study participants were informed that participation in the study was on a voluntary basis. They were informed that all gathered information would be confidentially handled and collectively analyzed. The information obtained from them is used only for evaluation of the knowledge on measles vaccine and its cold chain management. A self-administered structured questionnaire was used to collect relevant information regarding socio-demographic characteristics, and knowledge-assessing questions.

Participants' knowledge was assessed on the measles vaccine and its cold chain management. For knowledge assessment, eighteen item close-ended questions were prepared and used, of which participants were required to respond by answering the correct option. Thereafter, correct responses were rated as score of one (1), whereas incorrect responses were given a score of zero (0). Thus, the maximum attainable score was 18. Scores of the participants were converted into percentages and the mean score was calculated. The "knowledge scores" were categorized as unsatisfactory (0%-69%) and satisfactory (70%-100%).

In addition, a seventeen items on-spot observation checklist was used to assess the availability and status of the refrigerator, adequacy of cold chain equipment, and logistics of the vaccination unit.

2.6. Data management and analysis

The data were entered using Epi Data version 4.3 and exported to Statistical Package for Social Sciences version 20 (SPSS-20) for further analysis. The logistic regression model was used to assess the relationship between the outcome (knowledge status of HCWs and predictor variables (sociodemographic factors). Crude and adjusted odds ratios were calculated with 95% confidence intervals and variables with *P*-value less than 0.05 were considered statistically significant.

2.7. Ethical considerations

This study was conducted after getting ethical approval from the University of Gondar ethical review board (No.V/P/RCS/05/535/2020). Permission was also obtained from the Gondar city administration health office. All information obtained from study participants was kept confidential.

3. Results

3.1. Characteristics of study participants

A total of 165 HCWs participated in the study. The majority of them aged 30-44 years (57.0%) with a mean age of (35.2±8.0) years. Majority of the HCWs were females (62.4%) and nurses (61.8%) by profession. Over 75% of the HCWS have more than five years of work experience. Ninety percent of the participants are degree holders. Interestingly, 125 (75.8%) of the HCWs had over 5 years of service in the health sector (Table 1).

Table 1. Distribution of study participants by sociodemographic characteristics in Gondar city administration, Northwest Ethiopia, 2022 (*n*=65).

Characteristics	Number (%)
Sex	
Male	62 (37.6)
Female	103 (62.4)
Age, years	
18-29	49 (29.7)
30-44	94 (57.0)
45-60	22 (13.3)
Work experience, years	
0-4	40 (24.3)
5-10	56 (33.9)
>10	69 (41.8)
Educational status	
Diploma	13 (7-9)
BSc and above	152 (92.1)
Profession	
Nurse	102 (61.8)
Midwifery	21 (12.7)
Physician	6 (3-6)
Health officer	14 (8.5)
Pharmacy	14 (8.5)
Environmental	8 (4.9)

Table 2. Proportion of healthcare workers who provided correct repose to the knowledge questions on measles vaccine and its cold chain management (*n*=165).

Questions	Number (%)
Availability of measles vaccine in Ethiopia	160 (96.9)
Measles vaccine type used in Ethiopia, MCV	60 (36.4)
The target candidates for measles vaccine	87 (52.7)
Can measles be caused by the vaccine	105 (63.6)
The place for routine measles vaccine admiration	120 (72.7)
The main purpose of measles vaccine	35 (21.2)
The content of measles vaccine, live attenuated	110 (66.7)
Safety of measles vaccine	136 (82.4)
Effectiveness of the measles vaccine	148 (89.7)
Appropriate compartment for measles vaccine storage	85 (51.5)
Route of measles vaccine administration	164 (99.4)
Recommended doses of measles vaccine	131 (79.4)
Recommended temperature for measles vaccine storage	136 (82.4)
Lifespan of measles vaccine after reconstitution	113 (68.5)
Techniques for monitoring t cold chain equipment	118 (71.5)
Common error(s) before administrating the vaccine	75 (45.5)
Common error(s) during administrating the vaccine	154 (93.3)
Common error(s) after administrating the vaccine	126 (76.4)

Table 3. Information on cold chain status and management at health institutions in Gondar City Administration Northwest Ethiopia (n=9).

Key characteristics on cold chain monitoring	Availability [n (%)]	
	Yes	No
Has all staff received annual update on vaccine management?	3 (33.3)	6 (66.7)
Is there updated vaccine management policy?	5 (55.5)	4 (44.5)
Is chart or logbook for temperature recording readily available?	8 (88.9)	1 (11.1)
Is the temperature of the vaccine refrigerator recorded twice a day?	7 (77.8)	2 (22.2)
Are the contact numbers to report a cold chain breach available?	8 (88.9)	1 (11.1)
Were deviations outside 2-8 ℃ reported to responsible department?	7 (77.8)	2 (22.2)
Were deviations outside 2-8 ℃ recorded and action taken?	8 (88.9)	1 (11.1)
Has the refrigerator shown defect or malfunction?	8 (88.9)	1 (11.1)
Were there gap between the vaccine and the wall of the fridge?	2 (22.2)	7 (77.8)
Dos the refrigerator has sufficient space for appropriate storage?	4 (44.5)	5 (55.5)
Does the power outlet have a sign "do not turn of the refrigerator"?	2 (22.2)	7 (77.8)
Are the thermometer probes placed correctly?	6 (66.7)	3 (33.3)
Is the accuracy of the thermometers checked?	2 (22.2)	7 (77.7)
Is there written procedure for what to do during power failure?	4 (44.5)	5 (55.5)
Is there alternative storage for vaccine in case of failure?	5 (55.5)	4 (44.5)
Are ice packs at the correct temperature available?	8 (88.9)	1 (11.1)
Are there thermometers for each refrigerator?	1 (11.1)	8 (88.9)

Table 4. Logistic regression analysis of knowledge of healthcare workers on handling, storage and administration of measles vaccine in health institution within Gondar city administration, Northwest Ethiopia, 2022.

Variables	Total	Knowledge status		Crude *OR* (95% *CI*)	*P* value	Adjusted *OR* (95% *CI*)	*P* value
		Unsatisfactory	Satisfactory				
Sex							
Male	62	29	33	1.47 (0.78-2.76)	0.236	0.59 (0.28-1.28)	0.184
Female	103	58	45	1		1	
Age, years							
18-29	49	32	17	0.12 (0.03-0.41)	0.001*	24.9 (3.64-170.1)	0.001*
30-44	94	51	43	0.19 (0.06-0.60)	0.005*	4.8 (1.37-17.14)	0.014*
45-60	22	4	18	1		1	
Work experience, years							
0-4	40	23	17	0.57 (0.26-1.25)	0.160	0.28 (0.05-1.47)	0.992
5-10	56	34	22	0.99 (0.24-1.02)	0.057	1.0 (0.42-2.41)	0.132
>10	69	30	39	1		1	
Qualification							
Diploma	13	7	6	0.95 (0.31-2.97)	0.933	0.84 (0.24-2.96)	0.784
BSc degree	152	80	72	1		1	
Profession							
Nurse	102	54	48	1.78 (0.31-10.14)	0.517	0.40 (0.05-3.12)	0.384
Midwife	21	11	10	1.82 (0.27-12.17)	0.538	0.29 (0.04-2.41)	0.254
Health officer	14	3	11	7.33 (0.87-61.33)	0.066	0.09 (0.01-1.04)	0.054
Pharmacy	14	9	5	1.11 (0.15-8.36)	0.919	0.78 (0.08-7.60)	0.834
Environmental	8	6	2	0.67 (0.07-6.87)	0.733	1.64 (0.13-20.38)	0.699
Physician	6	4	2	1		1	
Vaccination experience							
No	50	29	21	0.74 (0.38-1.44)	0.372	0.83 (0.317-2.174)	0.704
Yes	115	58	57	1		1	

3.2. Knowledge of healthcare workers on measles vaccine and cold chain

Of most of the HCWs, 115 (69.7%) had experience of measles vaccine administration. Of these, 88 (76.5%), 13 (11.3%), 12 (10.4%) and 2 (1.7%) were nurses, midwives, health officers and other health professional, respectively. Nearly all, 160 (96.9%) of the HCWs knew the availability of measles vaccine for routine immunization in Ethiopia. The majority, 105 (63.6%) of the HCWs did not correctly mention the type of measles vaccine used in the routine immunization in Ethiopia, which are measles-containing vaccines MCV1 and MCV2. One hundred thirty-six (82.4%) health workers correctly mentioned the recommended range of temperature (2-8 ℃) for measles vaccine storage. One hundred thirteen (68.5%) responded correctly that the vaccine after reconstitution should be used immediately (Table 2). The score of the study participants on the knowledge assessment questions were calculated out of 100%. The mean score of the study participants was 66.7%. Overall, 87

(52.7%; 95% *CI* 44.8%-60.5%) of the healthcare workers had unsatisfactory knowledge regarding measles vaccine and its cold chain management.

3.3. Vaccine handling and cold chain condition of the health institutions

The vaccination units at the nine health institutions (eight health centers and one comprehensive specialized hospital) in the city were observed using an onsite observation checklist. Four of the health facilities did not have a vaccine management policy. Six of the health facilities had not provided annual updates on vaccine management for all staff in the vaccination unit. All of them had at least one refrigerator for the storage of different vaccines. Out of nine health facilities, eight (88.8%) had a logbook or chart for temperature recording. In more than half the health facilities, the refrigerators did not have sufficient space for appropriate storage of vaccines and they don't have written procedures on what to do during failure. Four of the health facilities did not have alternative storage for vaccines in case of failure. Besides, nearly all the refrigerators at each health facility had defects or malfunctions such as poor seals and the doors opening easily. In three of the health institutions, the temperature probes were not properly placed. The majority (77.8%) of the health facilities had never checked the accuracy of temperature probes (Table 3).

3.4. Factors associated with knowledge and cold chain management of measles vaccine

In this study, knowledge of health professionals on the measles vaccine and its vaccine cold chain management was not significantly associated with nearly all the variables studied. However, the age range of the study participants 18-29 years (P=0.001) and 30-44 years (P=0.014) were observed as determinants of unsatisfactory knowledge on measles vaccine and its cold chain management as compared to participants whose age is greater than 45 years (Table 4).

4. Discussion

Despite the availability of routine vaccination and surveillance in Ethiopia measles, virus infection is still a common public health problem[13]. The vaccination coverage in the country for MCV1 and MCV2 was reported to be 59% and 9%, respectively, which is much lower than the WHO standard of 95%[9,13]. Because of low vaccination coverage, poor living conditions, poor infrastructure and defective cold chain management, frequent outbreaks of measles have occurred in many parts of the country[13,20,22].

In addition, inadequate knowledge about the vaccine and its cold chain management might have contributed to the frequent outbreaks of measles in the country. Hence, the present health institution-based study provides information on the knowledge of HCWs on the measles vaccine and its cold chain management. The study revealed that more than half of the participated HCWs (52.7%) had unsatisfactory knowledge about the measles vaccine and its cold chain management. The finding of the present unsatisfactory knowledge of HCWs is comparable with similar studies conducted in Gurage Zone (49.7%)[3] and Oromia Special Zone (53.5%)[20]. On the contrary, the proportion of HCWs with unsatisfactory knowledge in our study is higher than in another study conducted in the USA (39%)[23]. In the current study, ages of HCWs less than 45 years were significant predictors of unsatisfactory knowledge. On top of this, measles vaccine is a sensitive biological product that can easily be destroyed if handled incorrectly. Exposure to inappropriate conditions can affect the potency of refrigerated vaccines[24]. Vaccines require more complex handling and storage requirements due to increased temperature sensitivity and complicated immunization schedules[25]. The finding of this study suggests the need to improve the knowledge of HCWs in the area on the measles vaccine and its cold chain management by providing them with adequate training and supervision.

In Ethiopia, immunization against the measles virus was introduced in 1980, with the first dose of measles vaccination (MCV1) given at or shortly after 9 months of age through routine services[26]. Later in 2019, the second dose of the measles vaccine (MCV2) was introduced for routine service or supplemental immunization activities (SIAs)[8]. In the present study, we observed that the majority, 105 (63.6%), of the participants did not correctly mention the type of measles vaccine used in the routine immunization in Ethiopia, which are measles-containing vaccines (MCV1 and MCV2). Of these, 89 responded MMR and the remaining 12 and 4 respondents mentioned PCV and OPV, respectively. More than one-third (36.4%) of the HCWs perceived that the measles vaccine can cause measles following vaccination. This finding indicates the presence of a clear knowledge gap among HCWs in the study area.

One hundred thirty-six (82.4%) of the HCWs correctly mentioned the recommended range of temperature (2-8 ℃) for measles vaccine storage. This observation was comparable with a study done in central Ethiopia, where 78.4% responded correctly[27]. However, our finding is lower than a study in Oromia Special Zone, Amhara region (96.9%)[20] and higher than a study in Guragie Zone (51.3%)[3]. On the other hand study reports from Cameroon showed that 71.1% of the HCWs knew the optimal vaccine storage temperature. The variation in the knowledge of the HCWs might be due to differences in professional qualification, training and supervision.

In the present study, all of the health institutions included in

the study had at least one refrigerator for storage of the different vaccines. With exception of one health institution, all of them had log book for temperature recording. This observation is in line with the CDC recommendation[24]. Contrary to the CDC recommendation, temperature probe for refrigerators were not properly placed in three of the health institutions. More than two-thirds of the HCWs were aware of the importance of the use of thermometers to monitor cold chain equipment. Some of the improper practices identified in this survey were the refrigerators did not have sufficient space for appropriate storage of vaccines in more than half the health facilities; the absence of written procedures on what to do during refrigerator failure and the lack of alternative storage for a vaccine in case of failure. Similarly, studies conducted in Cameroon and Central Ethiopia indicates that some of their health facilities had improper vaccine storage[27,28]. Variations in infrastructure and routine practice across the health centers might contribute to the loss of potency of the vaccine[17].

Several studies done in different parts of Ethiopia were focused on full vaccination coverage. The present study provides specific information on the measles vaccine and its cold chain management. The present study has the following limitations: the number of health institutions included in this study was limited. Attitude and practices of the HCWs were not assessed, and the sample size was relatively small.

More than half of the HCWs in the study area had unsatisfactory knowledge of measles vaccine and its cold chain management. In addition, they had limited knowledge on the type of available measles vaccine in the country and its safety. Majority of the HCWs were aware of the storage temperature. However, the availability of properly functioning refrigerators and the use of temperature probes at the observed facilities need further improvement.

To ensure optimal immunization effectiveness, providing technical support and in-service training on the measles vaccine and its cold chain management for HCWs especially those who are working at the vaccination unit is necessary.

Conflict of interest statement

The authors declare that they have no financial or non-financial competing interests

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Authors' contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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