Factors Affecting the Routine Immunization Activities During a Disease Outbreak, Epidemic and Covid-19 Pandemic in Africa

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والصَّلَاة و الْسَّلام عَلَى أَشْرَف الْمُرْسَلِين ﷺ

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LIST OF ABBREVIATIONS

GHSA	Global Health Security Agenda
WHA	World health assembly
RSPI	Regional Strategic Plan for Immunization
CMYP	Comprehensive Multi-Year Planning
JRF	Joint Reporting Form
PHEC	Public Health Emergency of International Concern
NCDC	Nigeria Center for Disease Control
EOC	Emergency Operation Center
GPEI	Global Polio Eradication Initiative
cVDPV2	Circulating Vaccine-Derived Poliovirus
ACDC	Africa Center for Disease Control
IDIs	In-Depth Interviews
GAVI	The Global Alliance for Vaccines and Immunization
VARN	Vaccination Acceptance Research Network
IVI	International Vaccine Institute
EPI	Extended Program on Immunization
PPE	Personal Protective Equipment
SIA	Supplemental Immunization Activities
MCSP	Maternal and Child Survival Program
RED/REC	Reaching Every District/Reaching Every Child
APE	Agentes Polivalentes Elementary
IDP	Internal Displaced People
PCR	Polymerase Chain Reaction

ABSTRACT

Background: The emerging disease outbreaks and pandemics affect immunization activities. In Africa, it has contributed to a significant decline in vaccination coverage and the provision of essential health services. The contributing factors which affect the immunization activities are unclear and vary as per the country's situation and response strategy to the emerging outbreaks and pandemics. Hence, we aimed to explore those factors related to disease outbreak, epidemic, and covid-19 pandemic affecting the delivery of immunization services in Africa.

Methods: Our study is qualitative exploratory research, which included five countries selected using convenience sampling according to the regional classification of Africa by ACDC. Factors affecting routine immunization activities in the countries were identified through interviews with relevant stakeholders involved in vaccination services. The interviewees were selected using snowballing sampling, 4 participants from each country, twenty key informants ranking (routine immunization directors, national immunization officers, EPI officers, and some health workers and caregivers) were included for open-ended and semi-structured virtual in-depth interviews. Additionally, some parents were interviewed for their perceptions about vaccinating their children during the current pandemic. We also did a literature review on the impact of previous emerging disease outbreaks on routine immunization activities in the countries and the current situation of the COVID-19 pandemic. Supportive trend data based on measles vaccination coverage and disease rates based on WHO country reports over time were included. Data generated from the literature review and in-depth interviews were transcribed verbatim and analyzed using thematic analysis. We used the thematic framework to organize our findings; each country was identified according to the following variables: Country name, the current situation of covid-19, covid-19 impact on the following factors (health system, governance, and community), and the impact of a previous disease outbreak on the measles

immunization coverage. Findings were grouped according to the country's perspective. We compared factors during previous outbreaks and covid-19 pandemics in Africa and addressed some interventions that can support immunization activities during disease x outbreak.

Results: 40% of our participants emphasized that fear of infection was behind the interruption in the immunization activities during covid-19 pandemics. 35% agreed that movement restrictions limited many activities. Resource limitation and misinformation comes as an individual barrier representing 10-15%. Some of the addressed health system factors included: surveillance defect, human resource shortage, lack of training, infrastructure, and PPE inadequacy. On the community base: misinformation, vaccine hesitancy and refusal, and fear of infection were identified. Governance factors included: movement restriction, travel ban, closed health facilities, lockdown, and social distancing factors were addressed. Few gaps were identified, as providing the proper training to the health workers and the caregivers, community engagement, national planning, building a proper registry system with implementing the proper plans for fast service recovery after a pandemic. By fulfilling those gaps, we may be able to provide better access to routine immunization during a disease outbreak, epidemic, and pandemic.

Conclusions: The study addressed the various factors affecting Africa's routine immunization activities during disease outbreaks and pandemics. It also addressed the impact of a previous disease outbreak on the measles immunization coverage, which may predict the covid-19 impact on the immunization coverage. It is, therefore, essential for decision-makers to address those factors to ensure immunization coverage without any missed opportunities.

Keywords: vaccination, outbreaks, covid-19, factors, Africa, misinformation, hesitancy.

CHAPTER I
INTRODUCTION

1.1 BACKGROUND

Vaccines save lives! for a safer, more secure world from global health threats posed by infectious diseases, vaccination has been part of the public health response to the emergence of future pandemic illness. Aside from the Global Health Security Agenda (GHSA) action package, immunization has made a remarkable contribution to public health across the world, but more so in Africa. It assisted in the control, elimination, and eradication of life-threatening diseases.

In May 2012, WHO set a Global Action Plan for vaccination (GVAP) that has been endorsed by 194-member states of the World health assembly (WHA) to achieve equitable access to existing vaccines for people in all communities. However, immunization activities have met with many challenges to achieve the expected target for universal coverage. [1]

Not to mention that mass immunization campaigns, clinical trials, and other research also face barriers to achieve their targets. Moreover, vaccine hesitancy is a real issue in Africa because of limited data availability. In this study, we tried to understand challenges with the immunization activities in Africa with an in-depth focus on the impact of the outbreak, epidemic, and pandemic on the routine immunization activities. [2]

1.2 LITERATURE REVIEW:

WHO and UNICEF endorsed The Global Vaccine Action Plan (GVAP) 2011-2020 as a Global and Regional agenda with the vision of communities free of VPD (vaccine-preventable diseases, including diphtheria, neonatal tetanus measles, pertussis, and poliomyelitis) [3]. The GVAP target was to achieve 90% national vaccination coverage and 80% coverage in every district or equal unit for all vaccines in national immunization programs. [4] In parallel, The WHO Regional Committee recognized the Regional Strategic Plan for Immunization (RSPI) 2014-2020 during its 64th session with comparable objectives to the GVAP [5] seeking 90% national vaccination coverage and 90% of Diphtheria-Tetanus-Pertussis (DTP3) immunization in 80% of the neighborhoods. [4] It included Multi-Year Plans (CMYP) for firming up the national immunization systems to attain proper vaccination in the region.

Since 2000, the measles mortality has declined by 88% in the African Region, where 70% coverage for three doses of the diphtheria-tetanus-pertussis (DTP3) vaccine and the first dose of the measles vaccine has been achieved. However, the region is still struggling to eradicate the VPD morbidity, and mortality causes. [6] It is vital to observe the national coverage of routine immunization in Africa in recognition of the new vaccine introduction requirements, capacity development, data, and immunization coverage estimates. [7] Despite the progress in achieving the millennium development goals (MDGs), Africa is limited in achieving the sustainable Goal (SDGs) related to health and still far from achieving the GVAP targets because of the immunization programs' challenges. [8] [9] One of the biggest challenges that limit achieving the immunization coverage targets in Africa is the impact of disease outbreaks, epidemics, and pandemics through many factors.

Africa has been affected by many disease outbreaks, only in 2018, 36 African countries reported 96 disease outbreaks to the WHO African region. An elevated number of Measles cases have been observed during the 2013-2016 Ebola outbreak in Africa. The Ebola outbreak affected the measles immunization coverage in the region when most of the resources were allocated to support the Ebola response. The Ebola response strategy affected the immunization coverage lead to measles outbreaks and other vaccine-preventable diseases at that time.

On 30th January 2020, WHO declared the new Coronavirus (COVID-19) as PHEIC, the new Pandemic (caused by the novel SARS-Cov-2 virus), which has since drawn global attention and response. As of 13th October 2020, this global pandemic infected 38M cumulative cases, 26.4M were recovered, and 1.08M death was recorded worldwide. Almost all the African countries were affected by the pandemic, recording 1.5M cumulative cases, 1.3M recoveries, and 38K death. South Africa was the most affected African country with more than 693K Cumulative cases by the same date. Routine Immunization Activities are at risk of disruption due to the severe health system breakdown, the country lockdown, and the social distancing measures that have been taken in place to mitigate the COVID-19 pandemic. The same impact of Ebola is predicted to happen on the measles and other vaccine-preventable diseases coverage by the end of this Pandemic.

Outbreaks, epidemics, and pandemics disrupt the immunization activities in Africa through many factors not limited to:

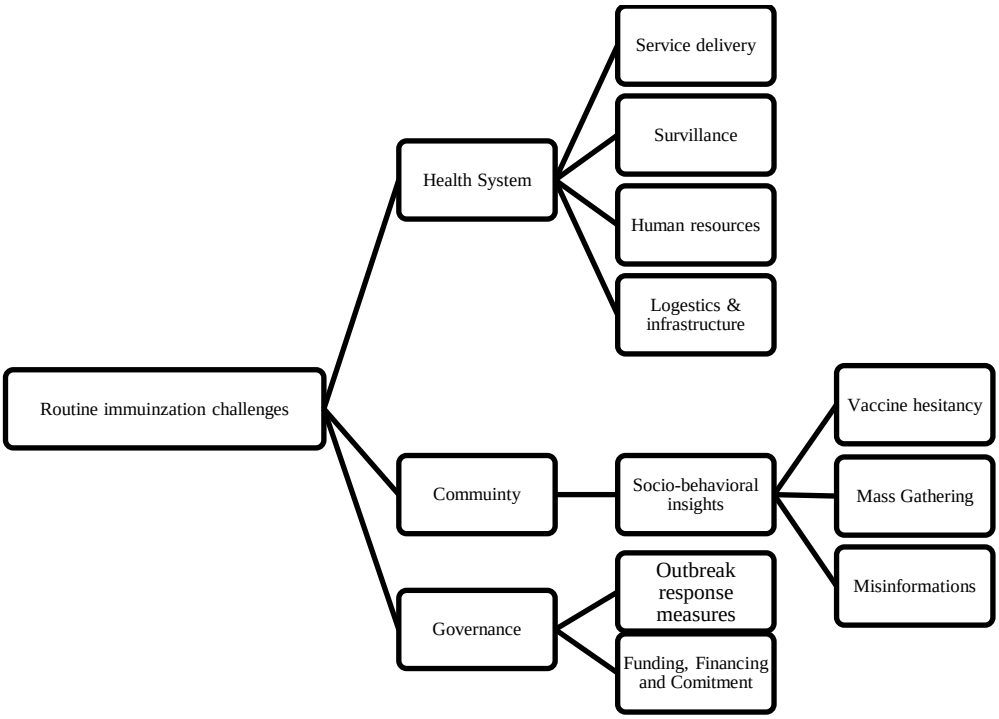

Fig.1.1: Framework of the contributing factors which affect the routine immunization activities in Africa.

1.2.1 Health system factors

i. Service delivery

In 2014, the Ebola virus disease (EVD) outbreak in West Africa reported 28,616 cases and 11,310 deaths in Guinea, Liberia, and Sierra Leone on 28th March 2016. [10] This outbreak was identified as the most massive and most persistent Ebola outbreak in history. It was declared a public health emergency of international concern (PHEC) by the WHO on 8th August 2014, under the international health regulations (IHR; 2005). Researchers predicted that the

EVD outbreak disrupted health care systems in the area, weakened the local health care system and the vaccine service delivery, and increased the number of susceptible children, leading to more deaths from vaccine preventive disease (VPD) than from EVD. [11]

ii. Surveillance

It is difficult to access the database and conduct surveillance during a disease outbreak without facing political, bureaucratic barriers. [12] The broken healthcare systems and community-based surveillance defect affect the surveillance systems of any kind. The basic health indicators (death rates, causes of death, or burden of disease), the surveillance for specific communicable and vaccine-preventable diseases face many challenges during a disease outbreak.

After 52 days of Zero reported Ebola cases by the country, the Ebola virus disease in the Democratic Republic of Congo is still active, as of 13th April 2020; the health authorities Reported two new confirmed cases of (EVD) in Beni. The unpredicted outbreak was raised after a formal declaration of the end of the outbreak was announced. that outbreak disturbs the surveillance system and the public health response measures in the country. [13] Although the immunization coverage was low before the EVD, it dropped further during the outbreak. Most Ebola-affected counties showed a higher decline than the least-affected ones. There was also a decline in the monthly reports received during the outbreak. [14]

iii. Human resources

During the EVD outbreak in Liberia, all planned national immunization campaigns were postponed. Due to human resource limitations, HCWs were not able to extend immunization through outreach services.[14] Meanwhile,

the fear of contracting EVD from the health care facilities prevented caregivers from pursuing immunization services for their children. Therefore the number of immunized children from all antigens decreased by almost 50% during this period in Liberia.[14]

iv. Logistics and Infrastructure:

In the twenty-first century, the WHO declared the first influenza Pandemic in 2009.[15] The 2009 pandemic of influenza A virus subtype H1N1 (A[H1N1] pdm09) infection spread quickly via human-to-human transmission to produce substantial morbidity and mortality worldwide was estimated that Africa had experienced the highest mortality. At that time, WHO supported the distribution of 900 million doses of the Pandemic influenza vaccine in low- and middle-income countries as a global response to the 2009 influenza. Unlike the developed countries, the vaccine introduction in Africa was affected by delays in the procurement, delivery, administration, and coverage due to logistical and infrastructure defects. [16]

Managing the cold chain equipment in areas where electricity is not available limits the introduction of multiple new vaccines in Africa. [17] Likewise, service delivery including supply chain, distribution, and transportation. [18, 19] Vaccine stock-out impairment [20] contributes to these issues especially when the country is reallocating all its resources to fight against a disease outbreak. An average of 38% of stock-out events was recorded from 2011-2015 in the Sub-Saharan Africa region[21]. The causes of these stock out events were primarily due to funding or procurement delays, management, and forecasting issues on the national level according to the WHO/UNICEF Joint Reporting Form (JRF) mechanism report in 2016 [22]. In-adequate infrastructure affected the immunization coverage in Africa for a long in

parallel to the limitation of the trained health care personnel with the distracted registration and administrative system.[23] [24]

1.2.2 Community factors

Socio-behavioral insights

i. Vaccine hesitancy

Vaccine refusal has been associated with outbreaks of many diseases in many African countries. While not much data is available, refusal to vaccinate has been witnessed in Africa. An increasing number of African citizens are delaying or refusing vaccination, although safe and effective vaccines are accessible. This Leads to deadly outbreaks of infectious diseases, which consumes resources and costs lives. Vaccine hesitancy is of global concern; however, we still are facing several knowledge gaps, mostly in Africa. Most of the researches on this topic has been conducted in high-income countries. Therefore, the knowledge about the nature and causes of vaccine hesitancy in the African countries is limited, with no evidence-based interventions.

On the other hand, the World Health Organization recognizes vaccine hesitancy as a priority issue requiring global attention. [25] Vaccine hesitancy is multifactorial and country-specific. [26] Unlike the high-income countries. Developing countries are facing different vaccine challenges. where vaccine hesitancy poses a complex interplay of structural and psychological influences. [27] WHO proposed the drivers of vaccine hesitancy as (5C model) confidence, complacency, convenience, risk calculation, and collective responsibility, based on research lead by WEIRD (Western, Educated, Industrialized, Rich, and Democratic) societies. [26, 28] [29] Parents play an essential role and sometimes can be barriers to their children's immunization. Vaccination schedules confusion, financial burden, culture, religious obstructions, and fear are some of the challenges facing children immunization

[30]. The hesitancy about vaccine effectiveness in comparison to natural disease immunity still exists [31]. Many parents believe that too many vaccinations may weaken the immune system or affect future disease incidence, and this also contributed to their vaccination hesitancy. [32] Community and media also influence vaccine confidence and acceptance in negative ways. News fabrication and sketchy reports of so-called vaccine reactions and anti-vaccination campaigns influence the parents and increase the hesitancy about vaccination [33] [34]

ii. Misinformation

Rumors, misinformation widely affected African society during the covid-19 pandemic. People do not trust their governments, and the source of their information is not accredited. During the recent covid-19 pandemic, rumors have been escalated that Africans would be used as clinical trials for the covid-19 vaccine. That misinformation affected people's perception of routine vaccination. Parents were afraid that their children might get injecting with dangerous vaccines instead of the safe and proven ones. People who are responsible for that misinformation used various channels to spread the rumors. For instants, in Senegal, many posts were shared on social media and Facebook that 7 children died after being vaccinated by the COVID-19 vaccine. Those posts were shared thousands of times within the society in both French and English.

iii. Mass gathering

2019 was a year of outbreaks in Africa, started by a Measles outbreak in Madagascar, Democratic Republic of Congo (DRC), Chad, Nigeria. Every 2-3 years, DRC suffers from a measles outbreak, but 2019 was the highest. reaching a peak of 311,471 reported cases compared by records 88,381 cases in 2013 – 133,802 in 2011 – 182,485 in 2005).[35] Mass gatherings were

behind the high transmission of measles, as reported that there were youth sports competitions, music festivals, and religious meetings. High population density, high birth rate, and poor access to vaccination, aligned with a high incidence of epidemics in Africa, pose a challenge to immunization coverage. Responsive vaccination campaigns appear to have been mostly responsible for the decline in the incidence of the measles outbreak in the Central Africa Republic, which is to be, commended in the face of continuing insecurity with the COVID-19 pandemic. There is, however, no room for complacency in a country with generally low routine vaccination coverage. [36]

1.2.3 Governance factors

i. Outbreak response measures

Following the WHO recommendations in responding to covid-19, each of the affected countries initiated a range of measures to mitigate the transmission of covid-19 and decrease healthcare systems' impact. Countries have implemented a travel ban, social distancing, temporary lockdown, and movement restriction measures to curb the spread of infection and minimize the virus's impact.

In structuring these measures, with the interruption of the immunization services, there will be a risk of morbidity and mortality from vaccine-preventable diseases (VPDs), impacting the global burden of disease. The delay of immunization services, even for short periods, may result in a higher risk of outbreaks (VPD-related deaths and increased burden on health systems that already overwrought by the COVID-19 response.

Moreover, on March 24th, 2020, the Global Polio Eradication Initiative (GPEI's) leadership called on all countries to postpone their mass campaigns and boost immunity to polio until at least the second half of this year. The targeted campaigns underway in Africa not only as a protective measure

against covid-19 but also to stop outbreaks sparked by the live virus vaccine itself where cases were reported in several African countries. As of April 1st, 2020, the world health organization reported two circulating vaccine-derived poliovirus cVDPV2 cases in the Democratic Republic of the Congo (DR Congo) – and five cVDPV2 cases in Ethiopia with five cVDPV2 cases in Ghana in a total of 12 new cases of the virus. By September, there are 50 cases reported in 2020, while the 2019 case count remains 88. [37] If under-immunized population defecated vaccine-virus still circulate for a period. The virus survives as the genetic mutation undergoes. On infrequent occasions, the vaccine-virus can genetically mutate into a form that causes the disease – this is what is known as a circulating vaccine-derived poliovirus (cVDPV). [38]

ii. Funding, financing, and commitment

Ministers, WHO, and the private sector have an essential role in increasing vaccine accessibility by commitment, robust delivery schemes, and improved data gathering to delivering the vaccine to each child in Africa. [39] As per 2011–2020 estimates, investing in the vaccine is a cost-effective intervention, where every paid dollar for vaccination would result in the return of 16 times of the costs, compared to the cost for treatment and productivity losses. Researchers estimated that the cost of fully vaccinating a child in the Region is at the $25–$45 range [40] [41] [42], not including service delivery, training, monitoring, evaluating, and tracking outbreaks. It was estimated that between 2016 and 2020, Africa would require $17 billion for vaccines and vaccination service delivery, where Governments were expected to support $6 billion and $6 billion coming from donors with a gap of $5 billion. Currently, Gavi supports most of the countries in Africa to implement their national immunization programs. Some countries allocated a budget for vaccination in their national plans but unfortunately did not utilize them to the expected degree. [2] Governments should invest more in immunization programs as the

low and middle-income gross domestic product increases, and their eligibility for donor funds for immunization decreases.

While the world attention focuses on the new Covid-19 pandemic on 24th January 2020, the Central African Republic Ministry of Health declared a national epidemic of measles. Over 3,600 cases were recorded, and 53 deaths were reported between February 2019 and January 2020. This made the authorities call for technical partners and the donor's support to immediately respond to this outbreak and secure enough vaccines, targeting all children aged between 6 months and nine years old. This was a mission that would be impossible with the lockdown measures and the travel panes taken by most countries worldwide. [36]

In parallel, on 25th January 2020, a new outbreak of Lassa fever was declared in Nigeria. Through its Centre for Disease Control (NCDC), Nigeria activated its national emergency operations center (EOC) in collaboration with national and international partners to the Lassa fever outbreak across different areas of the country. 195 confirmed cases and 29 deaths were recorded from 1st to 24th January alone across 11 states. Lassa fever is endemic in Nigeria, where the number of cases usually increases during the dry season in January due to weather conditions. Nevertheless, with the current situation and the country lockdown during the Covid-19 pandemic, shortages of critical treatment and response material possess a challenge to contain the outbreak. [43]

1.3 STUDY GOAL

To understand the factors affecting the immunization activities in 5 convenience selected African countries during the recent covid-19 pandemic.

1.4 STUDY OBJECTIVES

To indicate the factors affecting the routine immunization activities during disease outbreaks, epidemics, and pandemics.

1.5 STUDY QUESTION

What are the factors affecting immunization activities during various epidemics in Africa?

1.6 HYPOTHESIS

An outbreak, epidemic, and pandemic pose a barrier to immunization activities in Africa.

CHAPTER II

RESEARCH METHODOLOGY

2.1 STUDY DESIGN

This research type is a qualitative exploratory study that provides comparative information within and across countries on the impact of outbreaks and epidemics on routine immunization rates. It includes a detailed examination of the (health system, governance, and community) factors associated with responses to the covid 19. The study involves in-depth interviews and responses to a questionnaire with key informants to understand the challenges and impact of various outbreaks, epidemics, and the covid 19 pandemic on the country's routine immunization services within five selected African countries. We also did a literature review on the impact of previous emerging disease outbreaks on the routine immunization activities and the current situation of the covid-19 pandemic. This study's ethical approval was received from Yonsei University Health System, Institutional Review Board on 24th August 2020 with IRB approval number: Y-2020-0108.

2.2 UNIT OF ANALYSIS (COUNTRY)

Using convenience sampling, we selected 1 country from each region of Africa 5 countries according to the ACDC regional classification of Africa to compare our findings. The Countries are Nigeria (West), Democratic Republic of Congo (Central), Uganda (East), Egypt (North), and Mozambique (South).

Fig 2.1 The selected countries representing the 5 African regions.

2.3 DATA COLLECTION

Data collection took place from 24th August ~ 30th October 2020.

Using: Open-ended and semi-structured in-depth virtual interview questions (IDIs) with 20 participants working on different immunization activities in the 5 randomly selected countries. The interviews were conducted online using the WebEx meeting program. The same interview guide was used for all participants to identify variations.

The interview questions were set in categories, translated into (French, Arabic) and sent as a questionnaire to some participants in DRC and Egypt (due to language barrier). We received their answer by email. Follow up questions were sent to them for more in-depth answers. Additionally, some parents were questioned about their perceptions about vaccinating their children during the current pandemic.

Supportive trend data based on vaccination coverage and disease rates based on WHO country reports over time were included. Other supporting data were collected from WHO, UNICEF, GAVI Reports, UNDP, Vaccine confident project, Sabin vaccine Institute VARN, and Clinton health access initiative reports on immunization activities.

2.4 INTERVIEW PARTICIPANTS AND SAMPLING

Using Snowball sampling, we contacted our participants who play an active role in immunization activities at different health care delivery levels. Regional Level: multi-lateral agency representatives including WHO, ACDC, and IVI. On the National Level, we selected: Government Officials (MOH), Routine immunization directors, and Immunization Program Officers. With support from IVI research Staff, we identified further participants in the representing countries. On the state and local level: Doctors, Epidemiologists, Health care workers, health educators, and some Parents were interviewed from the selected countries. Additionally, some parents were interviewed for their perceptions about vaccinating their children during the current pandemic. 4 participants were interviewed/questionnaire from each country; in total 20 participants were included in the study. (Table 2.1)

	DRC	Uganda	Egypt	Moz.	Nigeria	Total
Regional Level:						
Researchers (IVI, WHO)		1		1	1	3
National Level:						
National vaccination officers		1	1		1	3
State:						
Routine immunization directors	1					1
Epidemiological surveillance and Mass Vaccination supervisors	1			1		2
EPI Officers (WHO)		1		1		2
Local						
Health Care Workers/ Caregivers	2	1	2	1	2	9
Total:	4	4	4	4	4	20

Table 2.1: List of Stakeholders interviewed

2.5 DATA ANALYSIS

Using a 4 steps thematic framework analysis approach [44], (Fig. 2.2) A close reading of the data revealed vital categories of events and processes that summarized segments of the data, which were then categorized under main themes: country name, covid-19 situation, the impact of previous disease outbreaks and the impact of covid-19 on the subcategories factors (health system, community, and governance). Reading through and coding all the transcripts and reviewing the segments revealed consistencies and variations in public health conditions, events, and processes that affected immunization coverage and public health responses. This process identified and confirmed the most significant findings. Assessing situations within countries were then compared and assessed with the findings across the countries' research sites. This process led to further identification and confirmation of core issues and analytical themes. Quantitative trend data over on childhood rates of measles and immunization coverage further illuminated the key informants' findings. This triangulation of qualitative data within and across countries and the quantitative rates of measles and immunization coverage supported the analysis and interpretation of the data

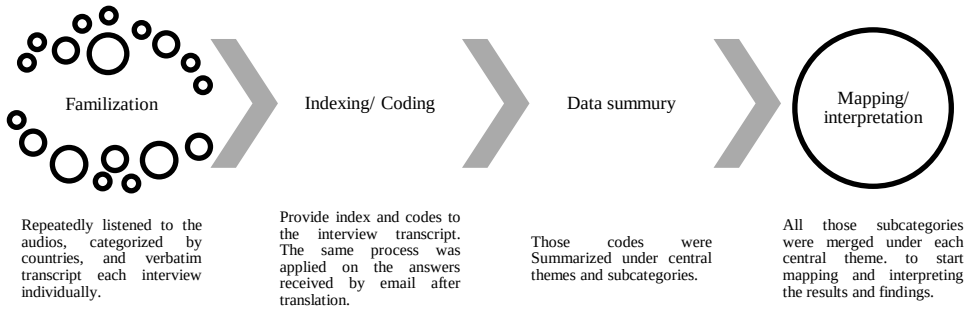

Fig. 2.2 Thematic Analysis Framework

CHAPTER III

RESULTS

3.1 FINDINGS:

3.1.1 The Democratic Republic of Congo:

i. The current situation of Covid-19 pandemic

By 27th November 2020, 55 new cases were reported, in total 12,365 cumulative cases (0.85 % of all the region cases). The attack rate of 13.15 per 100 000 population. 331 cumulative deaths with a CFR of 2.68%. 11,433 cumulative recovered (92.46% of cumulative cases). 600 active cases with prejudices, rumors, and false information circulating about the virus in the capital since declaring the first case. [45]

ii. The impact of covid-19 on the routine immunization activities

a. On the health system

On 15th Feb 2020, the first covid-19 case was imported from Europe to the capital city Kinshasa. Covid-19 is not the only outbreak of which DRC is struggling with recently. Since January 2019, over 6,500 children have died from measles, recording 335,000 infections. Over the past 18 months, DRC has responded to the second-worst Ebola epidemic in history with 3,453 cases and 2,273 deaths with an ongoing cholera outbreak. Considering the DRC's weakened healthcare system, responding to covid-19 was an additional burden to the country that could not afford it. Covid-19 did not only affect the routine immunization activities but also affected the surveillance and response to the other outbreaks.

b. On the community

Routine immunization activities and measles vaccination campaigns were slightly affected by the misinformation. People were afraid that the country could be used as a laboratory for a covid-19 vaccine trial. In which people may get injected with a dangerous trial vaccine instead of the proven ones. People mistrust of health system. "*They saw covid-19 is a business from westerners,"* said the immunization officer in Kinshasa.

In Kinshasa, between March and April 2020, the average number of children going to the health facilities for immunization dropped by 10%. The misinformation increased parents' hesitancy and refusal to vaccinate their children by the Extended Program on Immunization (EPI). The immunization coverage of all vaccines (hepatitis B, DTP3, IPV, and Hemophilus influenza type b) recorded an 8 to 10% decline. Coverage of other vaccines like MCV, yellow fever, and rotavirus recorded a 1.5 to 4.5 % decline. [46] *"Due to poor communication and misunderstanding of a certain portion of the population, some families refused to be vaccinated from common routine vaccines thinking that it was against covid-19"*, Said the Routine immunization activities supervisor of 10 health areas of East of Kinshasa.

c. On the governance

The pandemic response's biggest challenge was the lack of information, infrastructure, funds, and personal protective equipment, besides the limited international organization involvement. Responding to the covid-19 was a country's responsibility as most of the partners were overwhelmed by responding to the pandemic worldwide.

The government limited the public movement, social gatherings, and advocated for mask-wearing and hand hygiene practices. They also provide free access to

healthcare for all the population. Implementing those measures has been hard because of the logistics challenges, human resources, and rumors that disrupt the health system's functioning. A portion of the population even denial covid-19 existence with no respect for the preventive measures.

On the other side, the Democratic Republic of Congo (DRC) continues its routine immunization activities to tackle measles outbreaks in the North Kivu province, east of the country. This outbreak response campaign, launched on 21 April 2020, targeting 150,491 children aged 6 months to 5 years in the 7 most-affected health zones in North Kivu province. Moreover, the government set up communication assistants and health community workers to sensitize community mothers on the importance of routine immunization for their children's well-being.

iii. The impact of previous outbreaks, epidemics, and pandemics on the immunization activities.

From (fig 3.1), we can see that the MCV1 immunization coverage was around 74% since 2010, which is below the 90% target. This low coverage resulted in several measles outbreaks in the following years. In 2012 -2014 Ebola outbreaks hit the Democratic Republic of Congo (Appendix 3).

MCV1 coverage faced a sharp decline in the year 2012, resulting in a second peak of the total measles number of cases in 2013. That made the country increase the coverage to reach 78% in 2015.

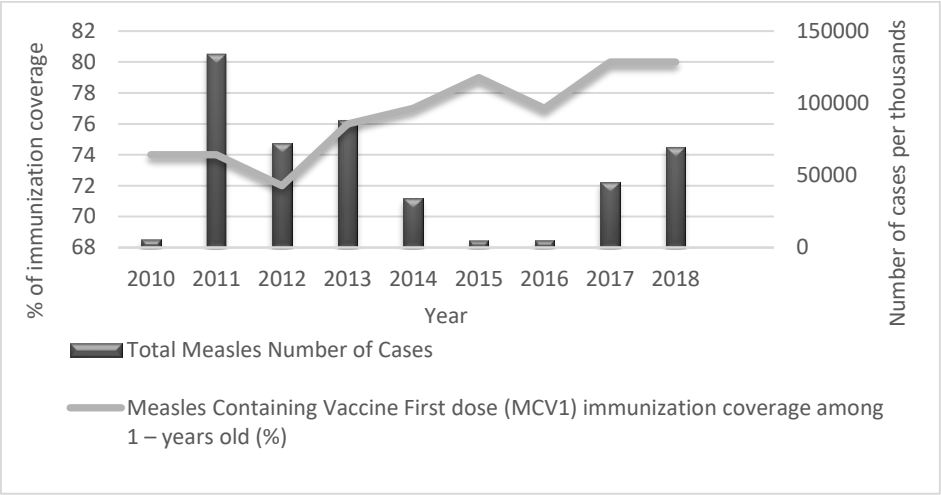

Fig. 3.1: The impact of the 2012-2014 Ebola outbreak on the MCV1 immunization coverage among 1-year-old % in DRC.

MCV2 introduction has another effect on those outbreaks. DRC Could not meet the criteria for MCV2 introduction of > 80% coverage of MCV1 at the national level for 3 consecutive years. The Ebola Outbreak affected the child health services delivery in Eastern Congo. It was found that vaccine uptake was dropped sharply during the Ebola period in comparing the vaccine uptake in pre-Ebola and the Ebola period. [47]

During the 2018 Ebola outbreak in DRC, there was a decline in all received vaccines compared with the pre-Ebola period (May-July 2018). There was an overall decline in the number of children receiving vaccines during the “Ebola period” due to a decline in health services use and community perception of increased risk of contracting Ebola. Besides the “no-touch” policy. Health care workers were ordered not to practice invasive procedures. This contributed to the disruption in the immunization provided. The priority was given to the Ebola response with a decline in the vaccine supply chain’s logistical support.

3.1.2 The Federal Republic of Nigeria:

i. The current situation of Covid-19 pandemic

Many socioeconomic factors affect the response to the covid-19 pandemic in Nigeria, including the high population density, high poverty, and limited healthcare access (Appendix 4). By 27th November 2020, 198 new covid-19 cases were reported in Nigeria, 66,805 cumulative cases (4.58 % of all the cases in the region). The attack rate of 32.24 per 100 000 population. 1,169 cumulative deaths with a CFR of 1.75%. 62,493 cumulative recovered (93.55% of cumulative cases). 3,143 active cases. Despite the global trend, more young people were affected by the new coronavirus in Nigeria than older people. [45]

ii. The impact of Covid-19 on the routine immunization activities

a. On the health system

Although the country's efforts to contain the disease, this pandemic has exposed the fragile health system, the inadequate testing capacity, the weak health infrastructure, and the sub-optimal health investment and funding challenges in Nigeria. The current pandemic indirectly affects the epidemiology of other endemic diseases in Nigeria. Like the Lassa fever epidemiological trend that indicates the highest case peak reported in 2020. It also affects the response to malaria, cholera, measles, yellow fever, and cerebrospinal meningitis outbreaks through the limited resource allocation and the inadequate national public health working capacity. Due to Covid-19, these supplemental immunization activities in Nigeria that achieved 65-73 % improvement in the routine immunization coverage by 2019 were pushed back from its 2020 targets. Most of the routine immunization activities are carried out in primary health care centers. In the early stages of the pandemic, the primary health care centers were closed, and the routine immunization activities were temporary suspended over the country.

b. On the community

People's perception of immunization is on change. Hesitancy, traditional, religious, and cultural misconceptions are significant issues in Nigeria. People look with suspicions about the vaccine. They find it not safe instead it is harmful, especially in the northern part. They believe it is another means of reducing their population. People trust and community outreach is becoming increasingly difficult during the pandemic. There had been a worrying decline in client attendance at health facilities in Kano province due to lack of awareness of continued routine immunization, as well as fear of COVID-19 infection. Some health care workers were also afraid to go to work as a few of their colleagues tested positive for the virus.

c. On the governance

Nigeria has recently improved in implementing routine immunization activities and Supplemental Immunization Activities (SIA). However, it was recorded that more than 3 million children under 1-year-old remain unvaccinated in the country. Inadequate access to health care, Vaccine hesitancy, and vaccine administration fees were the barriers behind getting the children fully immunized. Over the last year, the country made efforts to reach every vulnerable child through the emergency coordination centers that help reach the target population through house-to-house immunization visits to the hard-to-reach communities. The ban on movement also prevents the parents from taking their children to immunization.

iii. The impact of previous disease outbreaks and epidemics on routine immunization activities.

The decline in the MCV1 coverage since 2010 resulted in a series of outbreaks in the following year. In 2012 Lassa fever hit the country. The same year, Nigeria witnessed the lowest MCV1 coverage reaching 42%. Another slight decline was

recorded from 2014-2015, while the country was fighting Ebola and cholera. (Fig 3.2)

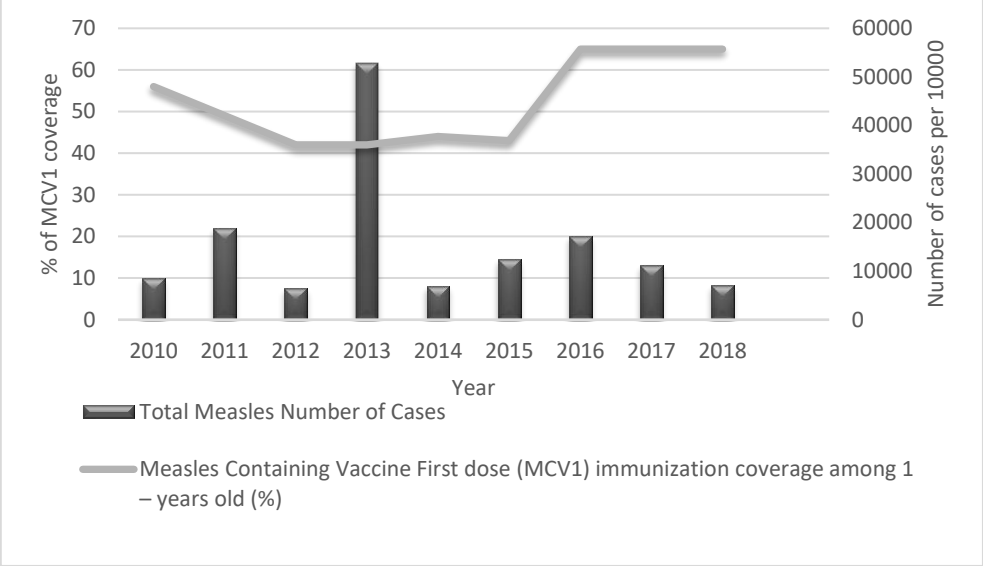

Fig. 3.2: The impact of 2012, Lassa fever, and 2014 Ebola outbreaks on the MCV1 immunization coverage among 1years old% in Nigeria.

3.1.3 The Republic of Uganda:

i. The current situation of Covid-19 pandemic

As of 27th November 2020, 484 new cases were reported in Uganda, 18,890 cumulative cases (1.29 % of all the region cases). The attack rate of 38,51 per 100 000 population's new reported death, 191 cumulative deaths with a CFR of 1.01%. 8,832 cumulative recovered (46.75% of cumulative cases) and 9,867 active cases.[45]

ii. The impact of Covid-19 on the routine immunization activities

a. On the health system

Covid-19 has affected most of the essential activities, including vaccination in Uganda. Country lockdown disabled people accessing the health services and

disabled the health workers from moving to their workplace after public transport was banned. Nurses were afraid to interact with the people in such a pandemic situation. 1.5 million school-going children have missed the Human Papillomavirus vaccine due to lockdown and school closure.

b. On the community

Most of the confirmed covid-19 cases were in Kampala a with a population growth of 1,507,080 people. Urban areas in Uganda have low immunization coverage in comparison to the rural areas, and that disrupts the immunization activities even more as a hesitance by the community to access the facilities during an outbreak of a fear to get infected.

c. On the governance

The Ministry of Health successfully contained the disease following the WHO and other international organizations' instructions in response to this pandemic. Moreover, early detection of cases and response measures with proper health hygiene mask-wearing and social distancing. The Ministry distributed around 13,455,657 masks and tested about 381749 suspected cases as part of its response to the pandemic.

Uganda was lucky in the current situation since they had a stock of the PPE and masks due to their fight against the imported Ebola cases coming from DRC. Due to this support from WHO and others, Uganda was able to contain the covid-19 Pandemic. Moreover, UNICEF supported health workers in the country by 12,000 pieces of PPE and (chlorine, hand washing soaps, and sanitizers) were supplied to the health facilities. On the other side, before the pandemic, Uganda prepared stock of its routine vaccines, which facilitate conducting its immunization activities although the global lockdown.

iii. The impact of previous disease outbreaks and epidemics on routine immunization activities.

The total Measles number of cases in Uganda has increased to record a peak of more than 8000 cases in the year 2013 (Appendix 3). While Measles containing vaccine first dose (MCV1) immunization coverage among 1 – years old (%) were progressively increased to decline again by 2014 (Fig. 3.3). In 2013, many measles cases were attributed to immunization coverage level; it was below the target level of 95%. With the catchup campaign in 2015, Uganda succeeds in increasing the coverage.

2014, Uganda was suffering from Marburg hemorrhagic fever. The MCV1 immunization coverage started to decline in the same year. (Fig.3.3) Recalling the Ebola outbreak in 2019 caused a 1- or 2-month disruption in the immunization activities. While the country was trying to contain the disease, the health workers were running out from the facilities, and the community refused to access the health facilities to seek the service. The same factors were behind the 2010 immunization disruption during the yellow fever outbreak. People fear to go to the facility, and health workers were afraid to go to the community.

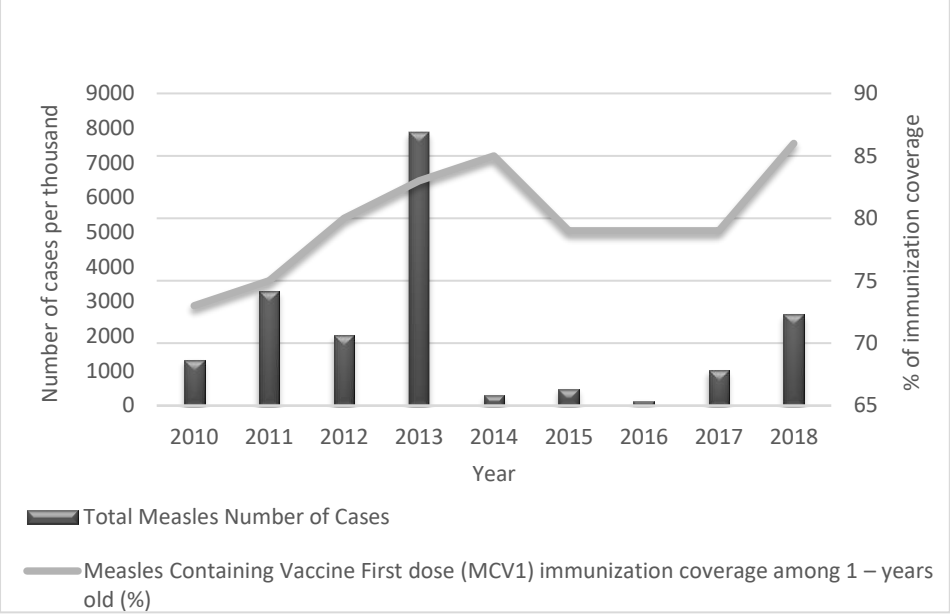

Fig. 3.3: 2014 Marburg hemorrhagic fever outbreak impact on the MCV1 immunization coverage among 1-year-old % in Uganda.

3.1.4 The Republic of Mozambique

i. The current situation of the Covid-19 pandemic.

As of 27th November 2020, 71 new cases were reported in Mozambique, 15,302 cumulative cases (1.05 % of all the region cases). The attack rate of 47.82 per 100 000 population. 1 new reported death, 128 cumulative death with a CFR of 0.84%. 13,459 cumulative recovered (87.96% of cumulative cases) and 1,715 active cases.

ii. The impact of Covid-19 pandemic on immunization activities.

a. On the health System

The capital, Maputo, and Cabo Delgado province are the epicenters of the outbreak in the country. Over the past year, more than 162,000 people in Cabo Delgado have been affected by insecurity due (drought, cyclones, floods, and violence). People

are living in overcrowded conditions in host communities. This has left at least 2.5 million people in urgent need of humanitarian assistance across the country. People's socioeconomic status is inferior, with 50 percent of the population living more than 20 kilometers from the nearest health facility (Appendix 4).

Priority was given to limited resources to the recent pandemic.[48] Routine immunization coverage was decreasing, putting Mozambique at risk of outbreaks of semi contagious diseases like measles. The significant disruption was addressed in the outreach sessions to the remote area where 33 % of children live over 30 minutes away from the nearest health facility. The maternal and child survival program (MCSP) in Mozambique uses reaching every district/reaching every child (RED/REC) strategy at health facility levels and in communities to improve immunization rates. Due to covid-19, this service was disrupted, and the outreach sessions were canceled. Immunization staff and surveillance workers were redeployed for the response of covid-19. IPV (polio vaccines), Rota, and DTP; reached the buffer stock. Vaccine stock limitation with the global travel ban was another big issue in Mozambique.

b. On the community

Although the government tried to follow the international guidelines in response to the pandemic, most people do not follow these control measures. Markets, beaches, and public places are still overcrowded. However, more than 10.000 people lost their work in 1 week due to those measures. People who survive covid-19 will die due to socio-economic constraints in Mozambique. Vaccine hesitancy is very limited in Mozambique since people are aware of vaccination's importance to their children's health. This public knowledge came from the government efforts in community engagement by implementing the Agent Polyvalent Element program (APE's).

c. On the governance

Since the first Covid19 case was reported in March 2020, the supply chain areas were the most affected, including the port, airport handling, and warehousing sectors. The government issue some measures to control the virus transmission like (school closure, suspension of public gatherings, and tightening border controls. However, border control was not strict, as many covid19 cases were crossing the border with South Africa. The disease prevalence was more than reported due to limited testing capacity, reagents, and PPE shortage in all provinces. Most of the Covid19 cases were asymptomatic, and less than 200 cases are hospitalized.

The routine immunization program shows a constant decline of 30 percent in immunization coverage for MCV2 and the third dose of DTP. There was a reduction in demand due to the temporary disruption of the service. The movement restrictions affect a huge workforce employed by the sector of vaccination. [49] When the emergency state was elevated, people were advised not to go out, not to hospitals, and some vaccine consultations were canceled. Cabo Delgado city recorded the highest decline between March and April 2020. Reduction in access to the routine immunization activities was witnessed as people were afraid to visit the primary health centers for vaccination. It was recorded that 42 out of 126 health facilities are non-functional in at least eight districts.

iii. The impact of previous disease outbreaks and epidemic on the routine immunization activities:

Before Covid-19, multiple disease outbreaks—including cholera and malaria—were already stretching Mozambique's weak health systems, and health centers were damaged during the cyclones Idai and Kenneth. Internal Displaced People (IDPs) in Cabo Delgado face significant challenges in accessing primary health care.[50]

Total measles number of cases sharply increased in 2010 to decrease after the country's mass vaccination campaign in 2011. While the introduction of vaccine first dose (MCV1) immunization coverage among 1 – years old (%) has been progressively elevated starting 2012 to reach 85% coverage in 2013 (Fig. 3.4). In 2012 Mozambique implemented an innovation to the vaccine distribution system. They optimized vaccine transportation, recasting some roles and responsibilities, and increased data visibility. This new approach was behind the progressive increase in immunization coverage in the country. The cholera outbreak in Cabo Delgado and Nampula provinces reported 1,000 cases and 17 deaths to date. In response to this outbreak, the country was supported by vaccine and equipment stock before the lockdown of the country of Covid19 pandemic. (Fig.3.4) Cholera's impact on the routine immunization activities was not significant. The immunization staff was not involved in the cholera response. They were not required to provide the cholera vaccination. The community health worker was trained to provide the service not to disrupt the routine immunization service.

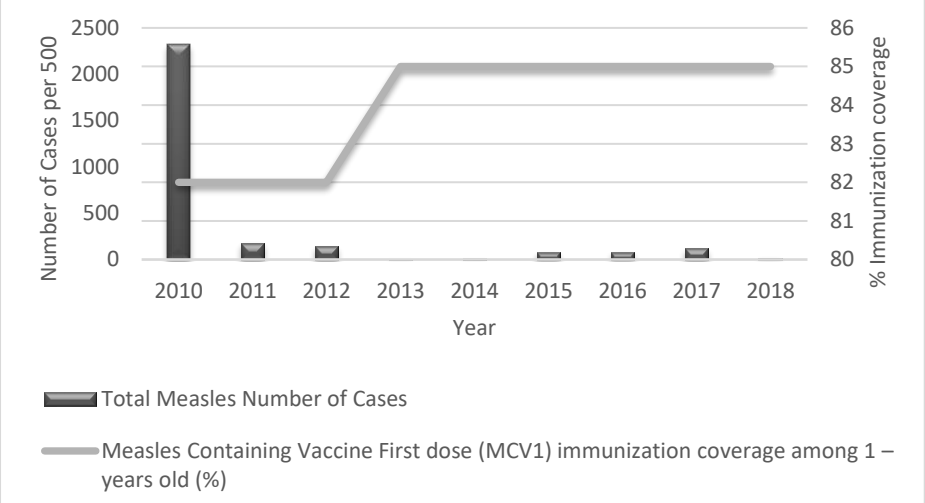

Fig. 3.4: 2018 Cholera outbreak impact on the MCV1 immunization coverage among 1-year-old% in Mozambique

However, a circulating vaccine-derived poliovirus type 2 (cVDPV2) affected Mozambique's routine immunization system in 2019 (Appendix 3) in the Molumbo district, Zambézia. The government had to deploy as much as possible health staff from all over the country to support the immunization campaign. Financial, human and material resources were deployed for polio.

3.1.5 The Arab Republic of Egypt:

i. The current situation of Covid-19 pandemic

Since the announcement of the first case of the SARS-CoV-2 on February 14, 2020, in Egypt, the government started multidisciplinary national coordination between different ministries and international organizations like WHO. As of 27th November 2020, 368 new Covid-19 cases were reported, 114,475 cumulative cases. 11 new reported death, 6,596 cumulative death with a CFR of 5.7%. 102,268 cumulative recovered (89.33% of cumulative cases). [51]

ii. The impact of Covid-19 pandemic on the routine immunization activities:

a. On the health system

As a primary response strategy to Covid19, the Ministry of Health was forced to change the traditional confrontation with the epidemic. Instead of hospitals being the first frontline for the disease, the health unit or health office located in every neighborhood or village is the first to deal with the disease. That decreased the burden on the referral hospitals and staff. Moreover, the Ministry opened the door to volunteering. Graduates of science, veterinary medicine, pharmacists, and dentistry were given a chance to play complementary roles in isolation and referral hospitals or with field investigation and follow-up teams.

The new strategy in response to covid-19 was a two-sided coin. Health units and primary health care centers are mandated to provide routine immunization activities in all governorates. The units' immunization service did not face much

disruption, like the nurses who provide vaccination were available to provide the service all the time. Vaccine stock and supply chain of the mandatory vaccination did not face any disruption in Egypt.

b. On the community

Fear of infection has escalated within the society about their children's safety while receiving the routine immunization services in the health units. Our research found that 60% of the responded parents were afraid of catching a covid-19 infection while visiting the health facilities. This fear was due to crowds in the health facility rather than being afraid of the vaccine itself. However, this did not stop the parents from going to the health facilities to vaccinate their children through the routine schedule.

Although their concerns, people were afraid that the delay in vaccinating their children due to the new coronavirus outbreak will have adverse effects on their future health. 95% of the responded parents vaccinated their children according to their routine immunization schedule without any delay. 100% were taking the safety measures of wearing the mask while receiving the services, and 95% agreed that immunization on time is vital for their children's health.

c. On the governance

In response to the current situation, the government followed the global guidelines of banning air flights, applying temporary country lockdown, and social distancing measures in crowded places. The government provided the health workers with the proper PPE and distributed 40 million fabric masks on the population ration cards system in all governorates.

The government increased media awareness about the importance of receiving routine immunization on time. Moreover, The MOH launched a new national campaign to vaccinate against polio, targeting those born between January 1, 2016,

until March 22, 2018. They put some strict measures during the campaign (only one person to be with the child to prevent overcrowding, wear musk and use hand sanitizer), noting that vaccinations are available in all health offices. This campaign targeted polio vaccination for 6 million children, and foreign children were also included.

iii. The impact of previous disease outbreaks and epidemics on the immunization activities.

In 2015, Egypt reported an outbreak of dengue fever. There was an increase in the total number of measles cases to above 5000, and the immunization coverage was declined from the year before to a record 92% (Fig 3.5).

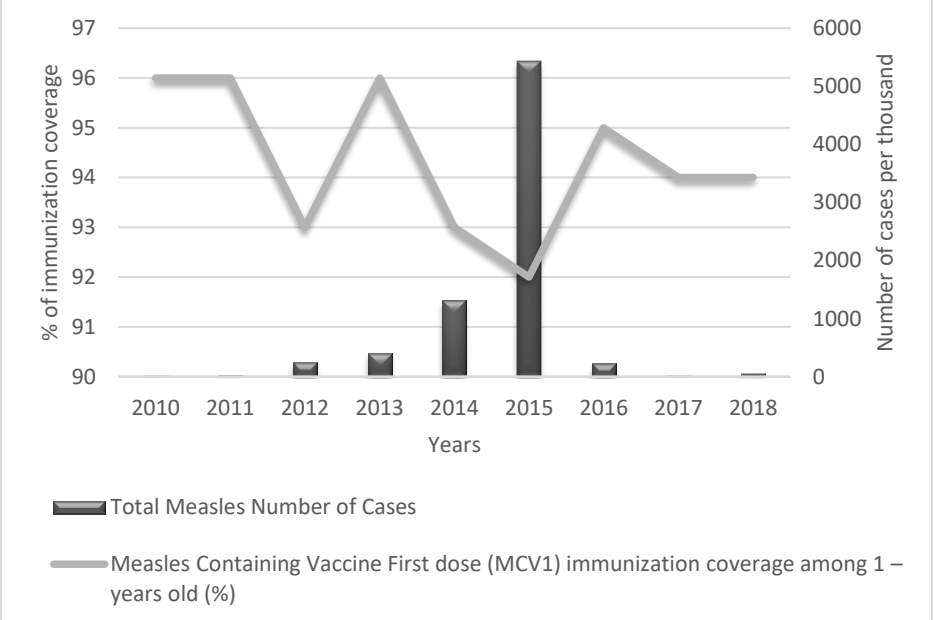

Fig. 3.5: 2015, Dengue fever outbreak impact on the MCV1 immunization coverage among 1-year-old % in Egypt.

In response to the 2015 measles outbreak, the health authorities in Egypt in collaboration with WHO and UNICEF conducted a national vaccination campaign

in the period from October to November of the same year. [52] 24 million children aged 9 months to 10 years were vaccinated in this campaign all over the Egyptian governorates in health care facilities, schools, and nurseries [52]. Since then, Egypt strengthens its immunization communication system to ensure that children targeted for vaccination are reached. That came in parallel to the national immunization campaigns that target the missed opportunities with vaccine promotion campaigns.

Summary

In summarizing our findings, 40% of our participants emphasized that fear of infection was behind the interruption in the immunization activities during the Covid19 pandemic. In contrast, 35% agreed that movement restrictions limited many activities. Resource limitation and misinformation became an individual barrier representing 10-15%.

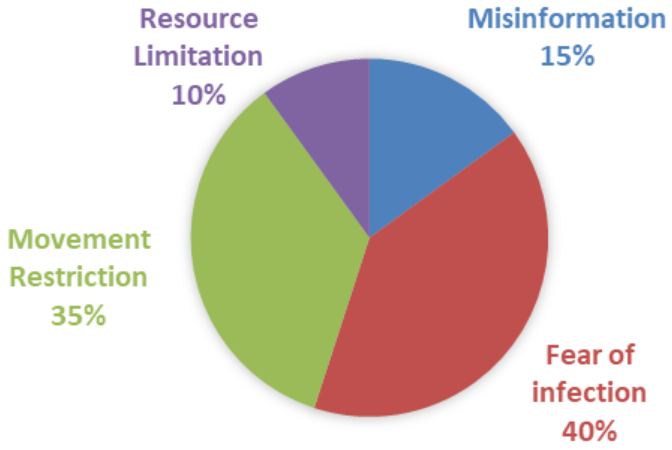

Fig. 3.6: Participants' response to the main factors affected the routine immunization activities during the covid-19 pandemic.

Between 2013-2016 the Ebola outbreak affected the routine immunization coverage in the region when most of the resources were allocated to support the Ebola response. The response strategy to the outbreak affected the immunization coverage leading to many measles outbreaks and other vaccine-preventable diseases. Covid-19 pandemic has a similar impact though with wider dimensions and magnitude due to its broad distribution, high infectivity, the burden on public health systems to mitigate and contain it, and its impact on social functioning in general, and the precautions and resistances of health care workers and families to participate in health systems.

Table (4.1) tried to address the thematic factors that may affect the routine immunization activities during a disease outbreak. Those main factors were supported by findings from the previous Ebola outbreak and the recent covid19 pandemic. In comparing the factors, we tried to conclude interventions for future disease x that may impact the routine immunization services.

Table 4.1 lessons learned, where immunization activities need to be strengthened with disease outbreaks/ pandemics.

Challenges	**Factors disrupting the routine immunization service during previous outbreaks.**	**Factors disrupting the routine immunization service during the Covid-19 pandemic.**	**Some interventions to support immunization activities during Disease x outbreak**
Health System	**Reduced health services** Priority was given to Ebola cases response; the EVD outbreak disrupted health care systems in the region, weakened the local health care system, and increased the number of susceptible children **The shortage of health workforce** In east Africa, the 'no-touch' policy affected the service delivery as HCW were ordered not to conduct invasive services. All planned national immunization campaigns were postponed due to human resource limitations. **Damaged infrastructures** Telecommunications, logistics transportation, and supply chain were very disrupted. Surveillance, outreach sessions, and campaigns were all suspended.	**Shortage of safety equipment's** Many countries could not provide the PPE to the health worker who provides vaccines due to resource limitations. **Limited human resources** HCW for vaccination service was unavailable because of movement restrictions or being redeployed to outbreak response duties. **Vaccine logistics and supply chain** were disrupted due to a travel ban and movement restriction.	**Health service** should be maintained and safeguarded during any disease outbreak **Ensure vaccine stockpiling** and equipment availability (syringe, masks, gloves, and PPE). Countries may advocate for the local production of the medical equipment. Regional companies can produce the PPE requirements to be used during vaccination that would offer a good solution in the case of a lockdown. **Capacity building.** Increase health care workers' knowledge and motivation. **Engage partners** and donors to ensure the supply chain to function well. **Free healthcare services** may result in increased use of services.

Community	**Fear of disease transmission** Information and awareness were minimal with no communication and protective measures that can decrease people's fear. **Rumors and Misinformation** affected people's trust in their government in response to the outbreak. **Vaccine hesitancy and refusal** Community resistance to vaccination, hesitancy about its effectiveness in comparison to natural disease immunity. **Culture and beliefs** The high population density, the high birth rate, and the poor access to vaccination aligned with a high incidence of epidemics. **Lack of Community awareness with** limited public health messages	**Fear of disease transmission** People were afraid of being exposed to the disease. Whether in the community or the health care facilities. **Rumors and Misinformation** People mistrust their government; they were afraid that the country could be used as a laboratory for Covid19 vaccine trials. **Vaccine hesitancy and refusal** People's misconception of vaccine safety was addressed. They were not able to access the services. People trust and community outreach is becoming increasingly difficult during the outbreaks.	**Provide social listening tools** to collect data (online and offline) **Social network analysis and media monitoring.** Media may influence in decreasing vaccine confidences and acceptance, fabrication and sketchy reports of so-called vaccine reactions and anti-vaccination campaigns influence in parent hesitancy about vaccination **Social inoculation, community sensitization,** and engagement with influencers and stakeholders in society can amplify and concrete messages to their constituents. (e.g, religious and youth organizations) **Rumors tracking and fact-checking** health-related claims and debunking, countering, and correcting false claims **Increase people's knowledge, attitude, and practice** of Non- pharmaceutical intervention. **Infodemic management,** support evidence synthesis, and science communication **Use of technology tools** to disseminate messages (hotline, website app Chatbots, SMS, etc.) **Provide event-based digital surveillance** of infodemic and misinformation.

Governance	**People movement across porous borders** Displaced and refugees who missed the vaccination in their country increased the governments' burden and affected the immunization coverage. **Political commitment** Some leaders demonstrated little interest in building laboratories and hospital capacity and better working conditions for conducting immunization activities. **Financial burden** Governance depends on foreign aid support. **Civil conflict** Countries affected by conflict suffer from; damaged infrastructure, exhausted human resources, limited vaccine accessibility, and availability that delay the vaccine's introduction and campaign implementation.	**Closing the primary health care center:** primary health care centers were closed as part of the government measures to limit public gathering. **Movement and Public transport restriction.** Because of movement restriction, people were unable to visit the health facilities. Furthermore, a house to house visits in the rural areas was disrupted. **Country Lockdown** affected vaccine supply chain and stock in some countries	**Governments** should set new policies to ensure that essential services maintain functioned under any circumference. **Proper strategic planning** for any emerging disease outbreak with budget allocation may help to decrease the financial burden. **Sharing experiences** can help improve other countries' strategies. **Engage partners** to support the outbreak response and safeguard the immunization services. **Afford ways** to bring the vulnerable communities to health facilities and provide the health workers with the proper training on how to deal with such a situation to contact the community. **Implement a proper registry system** for refugees and displaced persons indicating the immunization situation.

CHAPTER IV

DISCUSSION

In 2019, many African children missed out on life-saving vaccines. They were likely to lack access to the health service itself. Most of those children were concentrated in the Democratic Republic of the Congo and Nigeria. The places where disease outbreaks were one of the reasons to miss vaccine-preventable disease immunization. The immunization of children against various diseases has significantly decreased since the outbreak of the Covid-19 compared to last year, as many children around Africa are now unprotected from diseases.

Our study addressed that the reasons for the disrupted immunization services vary according to each country's situation, preparedness, and response strategy to each outbreak or pandemic. Even when services are offered, people cannot either access them because of caution to leave home, transport interruptions, movement restriction, or fear of being exposed to the disease.

However, during an outbreak, the interruption happened when the health facilities are overwhelmed by responding to the disease rather than promoting health or caring for primary health services like immunization. Many of the health care workers were redeployed in response to the outbreak. People were more concerned about the patients in the community rather than taking healthy children to immunization.

The misinformation increased parents' hesitancy and refusal to vaccinate their children by the Extended Program on Immunization (EPI). In DRC people were afraid that the country could be used as a laboratory for a COVID-19 vaccine trial. To overcome any immunization gap during the Covid19 pandemic, DRC continued its routine immunization activities with some modifications, including (social distancing measures and limiting the health care facility visitors). Health workers

who provide the vaccine were equipped with the proper PPE provided by UNICEF, and the public was advised to wear masks and practice hand hygiene measures. [53] This came in parallel to the measles response campaign targeting children aged 6 months to 5 years in the country's most affected areas with the same modifications to limit the COVID-19 transmission. The global response measures to COVID-19 affected public transportation and disrupted the vaccine logistics and supply chain. Vaccine stockpiling and equipment (Syringe, masks, gloves, and PPE) were limited during the global lockdown, especially in a landlocked country like Mozambique.

Moreover, COVID-19 did not only affect the routine immunization activities but also affected the response to the other outbreak. Immunization staff and Surveillance workers were redeployed for the response of COVID-19. This affects the indicators tracking for other suspected disease outbreaks. While the health facilities have been recorded as another big challenge due to the pandemic and lockdown in Nigeria. In the early stages of the pandemic, the primary health care centers closed, and the routine immunization activities were temporary suspended over the country. People's trust and community outreach became increasingly difficult during the pandemic.

The movement restriction disabled people from accessing health services and disabled the health worker's movement to their workplace. Nurses and vaccine providers were afraid to interact with the people in such a pandemic situation. In Uganda, school closures resulted in missed opportunities for the Human Papillomavirus vaccine by 1.5 million school-going children. In the same context, Fears have escalated within the Egyptian society about their children's safety while receiving the routine immunization services in the health units. However, people were afraid that the delay in vaccinating their children due to the pandemic, will negatively affect their future health.

In response to the current situation of the COVID-19 pandemic, the World Health Organization recommended that every country conduct an individual benefit-risk assessment. This report shall assist the decision-makers' ability to sustain the immunization activities during the pandemic based on the local transmission, the health system capacity, and the epidemiology of vaccine-preventable diseases. This kind of assessment shall predict the impact of COVID-19 on the routine immunization coverage in the region. Moreover, early this year, WHO and the Pan American Health Organization issued a guideline on the routine immunization activities during the COVID-19 pandemic.[54] Routine immunization activities were advised to be conducted in place while maintaining social distancing measures. However, many African counties lack adequately trained human resources and protective equipment to conduct the activities under such conditions.

The death prevented by sustaining routine childhood immunization in Africa outweighs the excess risk of COVID-19 death. Routine childhood immunization should be sustained in Africa as much as possible, considering other factors such as logistical constraints, staff shortages, and reallocation of resources during the pandemic.[55]Vaccine refusal has been associated with outbreaks of many diseases in many African countries. Vaccine hesitancy is becoming a more significant issue. Usually, it comes when introducing new vaccines and campaigns under the routine vaccine. It has been attached to the community and households because of their beliefs, and they recruit more people around the countries, not only in a specific area. During the HPV campaign for the 10-year-old girls in Uganda, some communities raise rumors that the vaccine causes infertility. That's why attached to girls, it also causes cancer. Outbreaks of polio were reported in Northern Nigeria due to vaccine refusal, and recently some communities in Nigeria encourage people to refuse their children's vaccination. People believe that vaccines are away from the government to reduce their population. Social, multi-ethnic, demographic, psychosocial, and multireligious factors with diverse cultural

beliefs were behind Nigeria's vaccine hesitancy. Further studies and interventions are needed to control this community's attitude before the problem gets bigger in Africa. Immunization act to punish people who encourage those ideas were advocated in many African countries. However, this may affect people's perception of vaccination and their trust in the government.

"*Heavy rain caused flooding in Kasese district in Uganda early this year, and it called for resources. Without the external support from the Red Cross, they would have affected all the facilities in the district*," Said the National Immunization Officer – Uganda. Planning for immunization in a humanitarian disaster can decrease the impact of such disasters on the immunization coverage. As witnessed during the current COVID-19 pandemic, most international organizations reallocated all its resources to respond to the pandemic. Hence, it is the country's responsibility for proper strategic planning in such a crisis. Disaster planning may save lives and prevent disease outbreaks.

"*Last year, Uganda discovered they are not producing enough vaccines, including measles. They had a fixed budget of 20 billion Ugandan shillings have been used for the last 10 years also. So, from 2010 if the budget for the vaccine is the same in 2019, then they are buying vaccines for the same amount to population growth. Somewhat the ministry of health and finance is not communicating to work out the mechanism of improving the financing of the vaccine to the population growth. 1.5 million children annually need to be matched with the resources*." Said the EPI officer, WHO- Uganda. Many factors are beyond the financial barriers to immunization in Africa. Besides providing the vaccine, Gavi support enables many African countries to address some of the critical barriers by supporting the health system and providing logistic support. However, it cannot meet all the demands. It should be from the government side to fill the other parts, but they still have financial constraints to fill the gap.

4.1 Recommendations:

COVID-19 is not the first and may not be the last pandemic. Countries should be equipped almost all the time with the essential equipment, adequate vaccine doses as a stock for emergencies. The governments need to have national planning for disasters and disease outbreaks; otherwise, we will always be going through such disease burdens. In overcoming the disruption that affects the immunization activities, the recovery should be speedy to avoid any long-term impacts. We addressed some interventions to support immunization activities during the Disease x outbreak (Table 4.1) as lessons learned from COVID-19. However, a Proper register system of all benefits in disasters is needed to Track who was immunized, who needs an immunization, and who has missed. To improve the performance as people are on the move over time.

There remain many opportunities to increase coverage. Community engagement can be enhanced to improve coverage through orientation/sensitization of community leaders and influencers on the importance of engaging caregivers and following up with those who default. Routine immunization activities should be safeguarded as much as is logistically possible, for continued service delivery, as part of the response to any disease outbreak in Africa.

CHAPTER V

CONCLUSION

In conclusion, infectious disease outbreaks, epidemics, and pandemics affect routine immunization and health services. The factors related to the impact of the COVID-19 pandemic were corroborated by the burden on public health systems and the delivery of routine immunizations that occur to varying degrees in disease outbreaks, epidemics, and pandemics. The study addressed different factors that may pose barriers to immunization during any future disease x outbreak, or epidemic. The impact of the COVID-19 pandemic has a similar impact, though with wider dimensions and magnitude. The impact of COVID-19 was due to its broad distribution, high infectivity, it's a burden on the public health systems, and the precautions and resistances that have been taken to mitigate it.

Disrupting the immunization coverage in Africa could be a revival of many vaccine-preventable diseases. Responding to any disease outbreak should be coupled with the strengthening of the routine immunization services to mitigate the risk.

STUDY LIMITATIONS

1. The study does not represent all of Africa's situation since we are doing it in only 5 countries with only 20 participants. Non-sample error; as the interviews were conducted online, internet connection and time zone differences were a big challenge.
2. Language differences were another challenge. For DRC and Egypt representatives, we had to translate the interview questions and share them by email. We received their correspondence in the same way. Away that may have some transcription differences. However, follow up questions were sent for more information and clarification.

APPENDIX

Appendix 1: Measles Containing vaccine First dose (MCV1) immunization coverage among 1 – years old (%) (2010-2018)

Year	**Nigeria**	**DRC Congo**	**Egypt**	**Uganda**	**Mozambique**
2010	56	74	96	73	82
2011	49	74	96	75	82
2012	42	72	93	80	82
2013	42	76	96	83	85
2014	44	77	93	85	85
2015	43	79	92	79	85
2016	65	77	95	79	85
2017	65	80	94	79	85
2018	65	80	94	86	85

https://www.who.int/data/gho/data/indicators/indicator-details/GHO/measles-containing-vaccine-first-dose-(mcv1)-immunization-coverage-among-1-year-olds-(-) [56]

Appendix 2: Total Measles number of cases from (2010-2018).

Year	**Nigeria**	**DRC Congo**	**Egypt**	**Uganda**	**Mozambique**
2018	7063	69693	48	2627	16
2017	11190	45107	24	1021	122
2016	17136	5092	225	139	NA
2015	12423	5020	5432	478	79
2014	6855	33711	1314	314	9
2013	52852	88381	405	7878	8
2012	6447	72029	245	2027	145
2011	18843	133802	26	3312	177
2010	8491	5407	16	1313	2321
2012	60	70	86	85	83
2011	60	70	86	85	83
2010	69	77	86	85	83

https://www.who.int/data/gho/data/indicators/indicator-details/GHO/measles---number-of-reported-cases [57]

Appendix 3: Infectious disease outbreaks from (2010 – 2020).

year	Nigeria	DRC Congo	Egypt	Uganda	Mozambique
2020	Lassa fever, Covid 19	Ebola, Covid19	Covid19	Yellow Fever, Covid19	
2019	Yellow fever, cVDPV2	Ebola, cVDPV2		Ebola	cVDPV2
2018	Lassa fever, Monkeypox, cVDPV2	Ebola, cVDPV2, Cholera		Typhoid fever	Cholera
2017	Yellow fever, Monkeypox, Cholera, Acute hepatitis E, Lassa fever, and Meningococcal	Ebola, cVDPV2		Marburg virus disease	
2016	Wild and cVDPV2, Lassa fever	Yellow fever		Yellow fever	
2015	meningococcal	Cholera	Dengue fever	Typhoid fever	
2014	Ebola	Ebola	MERC -Cov	Marburg hemorrhagic fever	
2013		Yellow fever	Polio detected from environmental samples		
2012	Lassa fever	Ebola, Cholera	Avian influenza	Ebola, Marburg	
2011		Cholera			
2010		Yellow fever			

https://www.afro.who.int/ [58]

Appendix 4: Socioeconomic Indicators (2018- 2019 estimates)

Country	**Nigeria**	**DRC**	**Egypt**	**Uganda**	**Mozambique**
Total population (2019)	201,748,529	87,468,059	100,075,480	44,422,562	31,156,700
Population under age 5 (millions)	32.9	15.2	13.0	7.5	4.9
Mortality rate, infant (per 1,000 live births)	64.6	701	18.8	35.4	53.3
Mortality rate, under-five (per 1,000 live births)	100.2	91.1	22.1	49.0	72.4
GNI per capita, PPP (current international $) (2018)	5,040	1,070	11,350	1,780	1,290
Gross national income (GNI) per capita (2011 PPP $)	5,086	800	10,	1,752	1,154
No. of districts/territories/ Provinces (2018)	774	519	27	122	161

http://hdr.undp.org/en/countries [59]

Appendix 5: Interview Questions

	Introduction	Welcoming remarks Study Brief
A.	**The situation of the country**	
	On the current situation of a covid-19 pandemic:	How many cases are detected in the country?
		What are the measures taken by the country in response to Covid19?
		Do you think the country faces challenges testing and containing this pandemic. What are those challenges?
B.	**Immunization activities**	Please tell us about the nature of your work in the country.
		Can you elaborate on your role regarding immunization?
		What is the impact of a covid-19 pandemic on the existing immunization activities in the country?
C.	**Impact of outbreaks,**	Do you believe that (country) is well prepared to deal with disease outbreaks like this?

	epidemic, and pandemic	What was the impact of these outbreaks on vaccination coverage? And how the country deal with those challenges?
D.	**Vaccine hesitancy**	How can you define vaccine hesitancy or refusal in (Country Name)?
		Does this increase during outbreaks? Do you think Public information and communications can solve this hesitancy problem? Please elaborate
E.	**Other barriers**	Have you faced other challenges conducting immunization activities in (Country Name)? What are those challenges?
F.	**Solutions**	What are the proper strategies to limit the impact of the outbreak, epidemic, and pandemic on the immunization activities in the country?
G.	**Recommendations**	Do you have other recommendations for future implementation to limit those barriers?

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