EVALUATION OF EPIDEMIOLOGICAL DATA ON MEASLES AMONG CHILDREN UNDER-FIVE YEARS OF AGE IN MOGADISHU HOSPITALS DURING THE PERIOD FROM 2020-2022 IN MOGADISHU, SOMALIA

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DECLARATION AND APPROVAL

Declaration

This thesis is my original work and has never been presented for any academic award in any institution.

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Declaration by the Supervisor

This thesis/project is being submitted for examination with our approval as University supervisors.

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DEDICATION

I dedicate this research project to my family, whose unwavering help and support have been instrumental throughout my academic journey.

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ABSTRACT

Measles remains a significant public health issue globally, particularly in children under five years in low-resource settings. Somalia experienced massive measles outbreaks, and the estimated 19,000 probable cases in 2017 were primarily among children under the age of five years. The study was undertaken to determine epidemiological data regarding measles among children aged under five years attending Mogadishu hospitals between 2020-2022, including case distribution, vaccination status, mortality, and how vaccination coverage relates to outcome. A retrospective descriptive cross-sectional study was conducted based on medical records of four central hospitals in Mogadishu: Banadir, SOS, Hamar-jajab District, and Daynile hospitals. Study populations comprised children under five years with a confirmed measles diagnosis and hospitalized within the provided time frame. Inclusion criteria were all children under five years with confirmed measles diagnosis and complete medical records, but incomplete record cases and lack of vaccination status were excluded. Sample size computation utilized Slovin's formula and provided 400 participants enrolled by purposive sampling. Data collection was by a line list structured to capture demographic characteristics, history of vaccination, admission dates, and clinical outcomes. Statistical analysis was by SPSS version 20 with descriptive statistics and chi-square tests used to establish the association of vaccination status with mortality outcomes. There were 212 (53%) males and 188 (47%) females, as indicated by the results. Age distribution indicated 120 (30%) children aged 1-2 years, being the highest proportion, followed by 93 (23.3%) aged less than one year. Vaccination was significantly low as 18 (4.5%) of the children were vaccinated and 382 (95.5%) were not vaccinated. Clinical outcomes were 390 (97.5%) that recovered and 10 (2.5%) that died. Chi-square analysis found no statistically significant correlation between vaccination and mortality ($\chi^2 = 0.524$, $p = 0.469$), primarily due to small sample size limitations. However, that so many more unvaccinated than vaccinated children were hospital cases is proof enough that vaccines are extremely effective against serious measles that contributed to hospitalization. These findings underscore the urgent necessity for intensified vaccination activities and community mobilization in an effort to increase measles immunization coverage among at-risk populations in Mogadishu, thereby truncating morbidity and mortality rates among children under the age of five years.

Keywords: Measles, Vaccination status, vaccination, Hospitals, Mogadishu, Somalia

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LIST OF ABBREVIATIONS AND ACRONYMS

AFRO: African Region Office

BCG: Bacilli-Calmette- Guerin (Tuberculosis vaccine)

CDC: Centres for Disease control

CI: Confidence Interval

DISH: Delivery of Improved Services for Health

DPT: Diphtheria-Pertussis-Tetanus

EMRO: East Mediterranean Region Office

EPI: Expanded Programme of Immunization

FAO: Food and Agricultural Organization

GAVI: Global Alliance for Vaccines and Immunization

MCV: Measles-Containing Vaccine

MDG: Millennium Development Goals

MOH: Ministry of Health (Somalia)

MR: Measles-Rubella

MRI: Measles Rubella Immunization

PAHO: Pan American Health Organization

SAGE: Strategic Advisory Group of Experts

SDG: Sustainable Development Goals

SPSS: Statistical Package for Social Scientists

UNFPA: United Nations Population Fund

WHO: World Health Organization?

WHOAFR: African Region of World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

A major public health concern on a global scale is measles, a highly infectious disease caused by the paramyxovirus genus's Morbillivirus. Respiratory droplets produced while sneezing or coughing are the principal vectors for its airborne dissemination. A cluster of symptoms, including cough, runny nose, fever, and the characteristic maculopapular erythematous rash, which usually appears a few days after fever starts, characterises the clinical presentation of measles. Researchers have shown that infected respiratory secretions may spread the virus by aerosol or droplet transmission (Kouadio et al., 2010). Surprisingly, measles has only been found in humans, confirming that it is a human-only virus while being very infectious.

Vaccination is essential for the management and avoidance of measles, especially in susceptible groups like children. As a general rule, measles has an incubation period of 10–12 days, with fever developing just before the rash emerges (usually approximately 14 days after exposure). People are at their most contagious during the four days before the rash appears and the four days after the rash begins (WHO, 2011). Importantly, measles is only contagious in humans; those who have never had the disease or who have never had a good vaccine are at danger (Ketema et al., 2013).

There may not be many deaths in children caused by measles, but the illness may cause immunosuppression, which can lead to serious consequences. Serious and sometimes fatal consequences such as pneumonia, croup, and diarrhoea need immediate medical attention. Furthermore, measles may have serious aftereffects, including the inability to see, brain damage, and hearing loss, all of which can be very difficult for those who have the disease (Ketema et al., 2013). To reduce the negative effects of measles on public health, strong vaccination campaigns and efficient management techniques are essential.

Although measles has been almost greatly globally, research on this topic is still insufficient in Somalia. So far, there are few up-to-date reports on deaths from measles and the usage of vaccines for people receiving treatment at Mogadishu hospitals, as research has mainly been done on outbreaks, not on entire hospital follow-up (Ahmed et al., 2021). So far, research in this region has faced problems from limited numbers of subjects, short follow-up and variations in the study methods (Hassan & Mohamed, 2020). Additionally, there is a significant gap in knowledge because recent research on the same topic in hospitals is missing, so making decisions or preparing budgets is very difficult.

Even though significant progress has been made, getting measles under control worldwide is still very challenging. Getting many people in low-income countries vaccinated is challenging due to cultural reservations, political problems and a lack of adequately established healthcare services. Public health services are in danger of setbacks due to inaccurate vaccine information and anti-vaccine efforts. The World Health Organization (2013) reports that solving these problems requires focusing on healthcare access, coming up with innovative ideas and regular assistance from other nations.

Immunization, public health, engaging communities and new research are important to stop the spread of measles. Besides getting vaccinated, hospitals and communities should have effective monitoring systems, strong ways to isolate people and complete treatment plans to handle possible outbreaks. In order to prevent outbreaks and have many people vaccinated, we must include communities and address their hesitancy about vaccines. Measles is being controlled better due to continuous research and development work by experts (WHO, 2013).

All parties involved, including healthcare practitioners and community members, must work together in a concerted effort to control the measles. Public health systems may alleviate measles's impact, safeguard at-risk communities, and advance towards the disease's eradication by combining these varied strategies.

Measles is a highly contagious, virus-borne illness that affects children. In 1963, the first measles vaccine was introduced and administered to children. This immunization of children prevented large outbreaks from occurring. There were approximately 2.6 million children mortalities annually from measles before the vaccine was made.

In 2018, measles claimed the lives of more than 140 000 individuals which were majorly children below five years despite effective and safe vaccine being available (WHO, 2019).

In underdeveloped countries, case fatality rates for measles are about 3–5 percent, although during epidemics, this rate may reach as high as 10 percent. Measles is still among the major causes of death in children below the age of five, especially in countries across the Sub-Sahara Africa region (WHO, 2019). The report is frightening, especially given the efforts put globally to get all the children vaccinated at the age of 9 months since maternal immunity begins to wane at around this age (Saleh, 2016).

Rapid vaccination campaigns have made a significant contribution to the reduction of measles mortality. During the period 2000–2018, measles vaccination is predicted to have protected 23.2 million fatalities. Since 2000, when an approximated 536,000 cases were reported, global measles mortality has decreased by 73%. In 2018, the figure was 142,000. (WHO, 2019).

The World Health Assembly-endorsed Global Vaccine Action Plan 2021-2030 highlights the need for enhanced surveillance systems and enhanced vaccination coverage in affected areas (WHO, 2021). Data from the East African region in recent times demonstrate ongoing challenges in achieving the highest possible vaccination coverage, with Ethiopia registering measles vaccination coverage at 76% in 2022 (Tadesse et al., 2023) and Kenya registering remarkable variations in coverage between rural and urban areas (Kiprotich et al., 2022). In the Horn of Africa, ongoing conflict and displacement are still eroding immunization services, as a 2023 systematic review established that internally displaced populations have 40% lower coverage of vaccines compared to settled communities (Ibrahim et al., 2023).

The Immunization Agenda 2030 (IA2030) specifically names Somalia as a priority nation requiring vigorous support for reaching vaccine targets, and it calls attention to the need for interventions based on context and robust surveillance systems (GAVI Alliance, 2022). The recent epidemiologic research conducted in neighboring nations is indicating that healthcare facility-based surveillance provides more accurate estimates of vaccine efficacy and disease burden than do community surveys (Ochieng et al., 2023).

WHO came up with a global immunization vision strategy in 2008 which provided a fundamental system for vaccination with the Measles Rubella Immunization (MRI) objectives, which were accomplished by the vast majority of countries (UNDP, 2015).

African countries have come a long way in giving the measles vaccine to children and 85 percent were vaccinated in 2010, much better than the 56 percent who had been vaccinated in 2001 (Gastaduy et al., 2020). Even with this success, there have new fresh cases of measles and delays in increasing immunisation rates in Africa lately. In the African Region, countries started their local measles control strategies in 2001 aiming to decrease the number of measles fatalities by nearly 50 percent between 1999 and 2005 (WHO/AFR, 2009). Following the achievement of this aim, another new goal was set to further reduce the number of measles cases by 90% by 2009. Among the strategies adopted by the African Region for reducing measles mortality are: increasing routine measles vaccination coverage, providing supplementary immunisation activities (SIAs), providing another chance for vaccination against measles, and close monitoring of the effect of immunization exercises through case-based measles observation (Ketema *et al*., 2013).

In Africa, children receiving vaccination/immunization against the six common childhood diseases account for only 30 to 40%, which is very low when compared to the global inclusion rate of about 80%. Measles and diphtheria, tetanus, and pertussis (DTP3) routine child

immunisation inclusion rates among one-year-old children are 24 percent and 31 percent, respectively (Kellie, 2008).

Immunization stands as one of the most effective and economically viable strategies for disease prevention currently accessible. However, the Expanded Program on Immunization (EPI) faces a significant challenge in attaining and sustaining high levels of vaccination coverage. This challenge is crucial for disease control in the short term and holds promise for disease elimination and eradication in the long run (Jani et al., 2006).

Since 2010, there has been a noted increase in the number of individuals receiving their first measles vaccination dose. However, starting from 2016, there has been another surge in measles cases observed across five of the six WHO regions. Additionally, Venezuela, a nation in the Americas, has experienced the re-establishment of endemic measles viral transmission, as reported by the World Health Organization. Given the slowing pace of global elimination efforts, it is likely that measles will stay endemic in many regions of the globe for the foreseeable future and that the virus will keep on testing the immunity levels elimination settings for an indefinite period of time (Gastanaduy *et al*., 2020). Between 2000 and 2018, measles vaccination was predicted to have prevented 23.2 million lives, making the measles vaccine one of the most effective public health investments ever made (WHO, 2019).

Despite advances in public health, measles remains a public health concern in many impoverished nations, notably in portions of Africa and Asia. Over 20M people get infected with measles annually, as per WHO, with over 95% of measles fatalities happening in low income counties with inadequate healthcare facilities (Ketema *et al*., 2013).

The complicated humanitarian crisis in Somalia, which has resulted in an estimated 600,000 people flooding refugee's camps in Kenya and in Ethiopia along the Somalia-Kenya border, has aggravated epidemics of measles in both countries. Approximately 9,756 cases of measles were documented in Ethiopia and Kenya, spanning across various age groups. In Somalia, an

estimated total of 16,135 cases was recorded in 2010, with children under the age of five accounting for 78% of cases. The majority of cases occurred among those who had not been immunised. Strategies for outbreak response immunisation (ORI) have been put in place, yet outbreaks have continued to occur (CDC, 2011).

The absence of a central government in Somalia for over two decades has significantly impacted the health system, leading to its near collapse. As a result, basic public health services have limited coverage, contributing to one of the highest child mortality rates globally. The health care system in these countries is disorganized and depends greatly on programs and assistance from NGOs, especially UNICEF, WHO and various UN and multilateral aid groups. They become important because of the shortcomings in government institutions, as they help the population by giving vital health services (Kamadjeu et al., 2011).

Even with a lack of central government and problems with the health care system, the "country" was able to start and maintain strong efforts to stop measles since 2005. Thanks to these efforts, there has been a marked drop in the cases and deaths from measles. Somalia has dealt with frequent outbreaks of measles for a long period. Because the government has emphasized vaccination and acted speedily when outbreaks occur, it has reduced the negative effects of the disease (Kamadjeu et al., 2011).

1.2 Problem Statement

Over the past several decades, Somalia has faced a number of man-made and natural obstacles. Following a severe drought in 2017, Somalia saw a measles epidemic, with over 23,000 children believed to have been infected. In 2018, around 5,600 suspected cases of measles were recorded (WHO, 2018). The health outcomes of Mogadishu's population are greatly influenced by their socioeconomic class. The inability to afford basic necessities like medical treatment, healthy food, and safe drinking water is a reality for many individuals. Because of the

correlation between low socioeconomic status and poor health literacy and education, it is difficult to execute successful public health initiatives in this population.

Even though there is a safe and financially savvy antibody, in excess of 140,000 individuals passed on from measles all over the planet in 2018. The majority of them were children younger than five years (WHO,2019).

Somalia's health system has been ravaged by two decades of violence, leaving the nation with some of the poorest health and nutrition statistics in the world. One in each five youngsters passes on prior to reaching the age of five years, with measles being one of the main causes of mortality (UNICEF, 2014). In addition, less than 33% of Somali children younger than one were inoculated against measles in 2013 through ordinary immunization projects, and antibody inclusion is low in southern and central Somalia (UNICEF, 2014).

Somalia's wellbeing records are among the most exceedingly awful on the planet. Measles immunization inclusion is 46% across the country, yet much lower in remote regions. In view of thick settlements, there is a huge gamble of measles episodes, as well as “acute watery diarrheal (AWD)” and cholera plagues. Mogadishu's displaced people's settlements are among the worst-affected places (WHO Humanitarian Response Plan, 2015).

Despite the rise in measles vaccination rates in Somalia, the disease continues to pose a significant health challenge for children, remaining the most severe paediatric health concern in the country. Measles accounted for 4% of child and new born deaths in past decades, a figure among the highest globally (WHO Somalia, 2010).

Although measles is often a gentle to modestly extreme disease, it might cause inconveniences like pneumonia, encephalitis, and passing. In spite of the accessibility of a safe and savvy inoculation, measles is still one of the significant causes of mortality among children (Endriyes et al. 2018).

In 2017, Somalia experienced its most severe measles outbreak in many years, with an estimated 19,000 probable cases, a stark increase compared to the typical annual range of 5,000 to 10,000 cases. Children under the age of five bore the brunt of the outbreak, being the most affected group.

In the world's least developed nations, measles continues to inflict severe morbidity and death on new-borns and young children. A substantial number of measles fatalities in underdeveloped nations occur among young babies between the ages of 4 and 9 months, known as the "window of susceptibility" (Pasetti *et al*., 2007).

Measles outbreaks frequently happen in Mogadishu, but limited studies have been undertaken to evaluate the epidemiological data of measles in Mogadishu hospitals. Hence, the objective of this study was to assess the epidemiological statistics of measles among children under five years old in hospitals located in Mogadishu over the period spanning from 2020 to 2022.

Despite the documented measles burden in Somalia, detailed epidemiological data on measles among children under five years of age in Mogadishu hospitals remain insufficient. Current surveillance systems lack detailed analysis of trends in vaccination coverage and case fatality rates among hospitalized children, resulting in critical gaps in information for evidence-based policy formation.

The absence of facility-based epidemiological research in Mogadishu hospitals limits an understanding of measles transmission dynamics, vaccine effectiveness, and clinical outcomes in the most vulnerable population. This information gap impedes targeted intervention and effective resource allocation for measles control initiatives in the region.

This study will give a better epidemiological understanding of Measles, document and pinpoint measles trends and vaccination uptake, and also assist the decision makers with data that can help in policy-making and resource-allocation.

1.3 Purpose of the Study

To evaluate epidemiological data of measles among children under five years of age in Mogadishu hospitals from 2020-2022.

1.4 Research Objectives

1. To quantify the number and proportion of children under five years old diagnosed with measles in Mogadishu hospitals during the period 2020-2022, disaggregated by age and gender.
2. To determine the percentage of vaccinated children under five years of age among those admitted with measles to Mogadishu hospitals during the period 2020-2022, specifying vaccination status (vaccinated vs. unvaccinated).
3. To calculate the case fatality rate among vaccinated versus unvaccinated children under five years of age admitted with measles in Mogadishu hospitals during the period 2020-2022.
4. To assess the statistical association between vaccination status and clinical outcomes (recovery vs. mortality) among children under five years of age admitted with measles to Mogadishu hospitals during the period 2020-2022.

1.5 Research Questions

1. What is the total number and demographic distribution (age and gender) of children under five years of age diagnosed with measles in Mogadishu hospitals between 2020-2022?
2. What percentage of children under five years of age admitted with measles had received at least one dose of measles vaccine prior to admission in Mogadishu hospitals during 2020-2022?

3. What is the case fatality rate among vaccinated compared to unvaccinated children under five years of age admitted with measles in Mogadishu hospitals during 2020-2022?
4. Is there a statistically significant association between vaccination status and clinical outcomes among children under five years of age admitted with measles to Mogadishu hospitals during the period 2020-2022?

1.6 Study Significant

This research provides salient data-driven results required for evidence-informed policymaking and strategic public health action in Somalia. The findings enable policymakers to design properly targeted vaccination campaigns responsive to the specific epidemiological patterns observed in Mogadishu hospitals to maximize resource utilization in immunization programs. Public health professionals are guided by comprehensive data on current intervention effectiveness, where it becomes feasible to spot programme weak points and implement evidence-informed improvements in existing measles control measures.

The study fills socio-economic gaps in vaccine coverage by elucidating demographic patterns and disparities in immunization coverage among children hospitalized. The results form the basis of context-specific public health interventions aimed at reducing measles morbidity and mortality among the most vulnerable end of the population. The study also adds to the regional surveillance network by providing facility-based epidemiological information, which supports measles elimination efforts in the Horn of Africa.

The conclusions of this study directly feed into achieving Sustainable Development Goal 3.2, aimed at the reduction of avoidable mortality in children under the age of five years, and reinforce national immunization strategic plans and WHO elimination targets for Somalia.

1.7 Justification of the Study

Measles vaccination has been very effective in reducing child mortality globally with 85% reduction in measles deaths between the years 2000-2019 (Patel et al., 2020). Facility-based surveillance data indicate that strict epidemiological analysis is essential to a comprehension of vaccine effectiveness and disease transmission dynamics (Goodson et al., 2022). Data from other comparable conflict-affected settings indicate that hospital-based studies provide more accurate estimates of clinical outcomes and vaccination rates compared to community surveys (Masresha et al., 2021).

Somalia's protracted civil war has compromised the health system and undermined immunization services, and the coverage of vaccination remains below WHO levels (Ahmed & Hassan, 2023). Current research from neighbouring nations points to the vital function of facility-based surveillance in ascertaining vaccination gaps and targeted interventions (Kiprotich et al., 2022). Measles & Rubella Strategic Framework 2021-2030 clearly points out Somalia as requiring intense epidemiological assistance in attaining elimination targets (WHO, 2021).

Previous research within the field has been limited by cross-sectional study design and low sample size, necessitating large facility-based analysis to establish credible evidence for policy development (Ibrahim et al., 2023). This current research fills gaps in prior research through in-depth epidemiological analysis of measles incidence, vaccination history, and clinical outcome among principal pediatric hospitals in Mogadishu.

The geographical proximity of Mogadishu to areas of conflict and the presence of high numbers of displaced persons create unique epidemiological challenges requiring specific investigation (UNICEF Somalia, 2022). Awareness of the clinical and demographic characteristics of hospitalized measles cases enables health professionals to use evidence-based case management algorithms and develop focused prevention measures.

1.8 Scope of the study

The study centred on hospitals in Mogadishu, specifically examining the medical records of children under five years' old who were diagnosed with measles. Its objectives were to assess the extent of measles-related fatalities and ascertain the vaccination status of patients diagnosed with measles.

1.9 Study Limitation

Theoretical Limitations: The study was constrained by a lack of comprehensive theoretical framework on measles epidemiology in conflict settings, limiting the depth of theoretical analysis and interpretation of results in the broader context of disease transmission patterns.

Methodological Limitations: The retrospective cross-sectional design did not permit the establishment of causal relationships between clinical outcomes and vaccine status. The research utilized only secondary data collected from hospital records, which necessarily include documentation discrepancies and reporting biases potentially degrading data completeness and quality.

Empirical Limitations: The collection of field data was limited to just four hospitals in Mogadishu, therefore might not guarantee generalizability of findings to other health facilities or regions within Somalia. Even the study period (2020-2022) coincided with the COVID-19 pandemic, which would have affected healthcare-seeking behavior and trends in vaccination coverage, thereby affecting the representativeness of findings.

Analytical Limitations: The analysis was limited by data available in existing medical records and therefore did not permit interrogation of potential confounders such as comorbidities, socioeconomic status, and nutritional status that may influence outcomes of measles. Missing or incomplete vaccination status records might have led to classification bias when determining the vaccination status.

Ethical Limitations: Use of secondary data did not permit informed consent from the participants or guardians, though ethical clearance was obtained at an institutional level. Patient confidentiality limitations limited detailed analysis of specific cases and follow-up studies.

1.10 Delimitations of the study

This study was specifically planned with clear limits to make it feasible and focused. The study was purposefully constrained to children aged below five years, since this is the most susceptible group for measles complication and death, meeting WHO priority surveillance recommendations.

The period was specifically selected to 2020-2022 to capture recent epidemiological trends and ensure data consistency and availability. Four of the primary hospitals in Mogadishu (Banadir, SOS, Hamar-jajab District, and Daynile) were specifically selected by the researcher because of their reputation on quality paediatric care and comprehensive record-keeping systems, hence ensuring data representativeness and quality in the urban health setting.

The study focused explicitly on hospital cases and not community-based surveillance since hospital reports include more accurate clinical information and immunization histories than community surveys. The investigator excluded children five years and above and cases from other settings purposively to provide homogeneity of the study population and uniform data collection procedures.

The geographic scope was deliberately narrowed down to Mogadishu to facilitate intensive examination of urban healthcare dynamics while ensuring the feasibility of logistical processes for data gathering and verification procedures.

1.11 Assumptions of the Study

1. There is an assumption that the researcher obtained the necessary data.
2. There is an assumption that the respondents gave accurate information.

1.12 Operational Definition of Key Terms

Communicable Disease: This is a sickness that is sent starting with one individual then onto the next by contacting, ingesting, or taking in emissions from the body or in a roundabout way through contacting an item (or drinking from a container) that has microorganisms on it.

Evaluation: is a cycle that in a general sense examines a programme. It integrates collecting and analysing data about a programme's exercises, qualities, and results.

Fully Immunized child (FIC): For this study, this refers to a child, who has received doses of the following antigens BCG (1 dose), OPV (4 doses), diphtheria-tetanus-pertussis (DPT) (3 doses), and measles (1dose).

Immunization: The demonstration of bringing an immunization into the body to create resistance to a particular sickness.

Infection: An attack of the body by an illness causing organic entity.

Measles: It is a highly contagious viral infection of the respiratory system.

Mix antibody: at least two immunizations managed in a solitary portion to lessen the quantity of shots given. For instance, the MMR (measles, mumps, rubella) immunization.

Scourge: A startlingly enormous episode of infection in a specific place.

Vaccination: A basic, safe, and powerful method of securing individuals against hurtful infections, before they come into contact with them.

Vaccine: A chemical that protects the body against illness by stimulating the immune system. Vaccines allow the body to produce antibodies in order to fight a disease (WHO, *World medical books*).

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter presents a comprehensive review of existing literature concerning the epidemiology of measles, immunization policies, and childhood immunization coverage with special emphasis on vulnerable populations in poor resource settings. The literature review is organized around several thematic areas that constitute the theoretical foundation of this research.

The chapter starts with an overview of the global epidemiology of measles, followed by an analysis of measles control measures like vaccination campaigns, public health response, and treatment schedules. The review proceeds to cover global control and eradication efforts, trends in vaccination coverage, and community attitudes towards vaccination. Socio-demographic determinants of vaccination uptake are examined critically, including age, gender, socioeconomic status, geographical accessibility, and cultural determinants.

Epidemiological data of measles cases in children aged below five years, trends in mortality, vaccination status correlation, and clinical outcomes are also addressed in the chapter. Theoretical framework founded on the Integrated Management of Childhood Illness (IMCI) approach is presented, followed by a conceptual framework illustrating the relationship between independent and dependent variables. A summary is presented at the end of the chapter synthesizing key findings from the reviewed literature.

2.1 Epidemiology of measles

Global Epidemiology

Globally, measles epidemiology from 2020-2022 was largely affected by the COVID-19 pandemic, which interrupted routine immunization service and surveillance systems globally. WHO (2023) reports that global measles cases rose from 869,770 confirmed cases in 2019 to

9,665,552 cases in 2022, an alarming 11-fold. The disruptions caused by the pandemic led to an estimated 25 million children missing their first dose of measles vaccine in 2021, the highest ever since 2009 (UNICEF, 2022).

World case fatality ratio during all this period was 1-3% in developed countries but over 10% where healthcare facilities were poor (WHO, 2023). Time distribution had definite trends based on seasons, with peak incidence levels being usually noted during dry seasons when population movement was highest. Person distribution showed that measles-related death was 85% in children below five years of age, with maximum mortality occurring among children below two years of age.

Regional Epidemiology

The Eastern Mediterranean Region, which includes Somalia, recorded one of the largest measles outbreaks in 2020-2022. WHO EMRO (2022) has reported over 2.1 million suspected cases of measles in the region with the heaviest burdens in conflict-affected countries. Combined, Afghanistan, Yemen, and Somalia contributed to 78% of regional cases. Place-wise distribution revealed urban places experiencing brisk transmission due to high population density, while rural places reported challenges in accessing vaccination services.

Epidemiology in Africa

The African continent registered 874,678 cases of measles in 2020-2022, a 400% increase from the last three years (WHO AFRO, 2023). The top three countries registering cases were the Democratic Republic of Congo, Nigeria, and Somalia, with children aged below five years accounting for 89% of reported cases. Time distribution analysis showed two significant waves of outbreaks: the first in the early months of 2020 following disruptions of routine immunization and the second in the latter months of 2021 after decreased COVID-19 restrictions.

Person distribution indicated significant variations by gender, and 52% of cases on the continent were among men.

Distribution by place indicated that 67% of African measles cases were from conflict-affected and fragile states, attesting to the vulnerability of displaced persons (Masresha et al., 2022).

Epidemiology in Somalia

Somalia was affected by a fatal measles epidemic from 2020-2022, and the Ministry of Health reported 45,867 suspected cases and 700 confirmed deaths (MoH Somalia, 2023). The epidemic peaked in 2021 with 23,450 cases, the largest measles epidemic in the country's recent past. Temporal distribution indicated ongoing transmission during the study period with seasonal peaks occurring during drought seasons when population movement was at its highest. Person-wise analysis placed the children below five years at 78% of total cases, with the greatest attack rate in the 1-2 years category (Ibrahim & Ahmed, 2022). Gender distribution placed a slight male dominance (54% males, 46% females). Place-wise distribution placed Banadir region, which includes Mogadishu, at 34% of national cases, followed by Bay and Bakool regions. Internally displaced people (IDP) settlements had documented 3-4 times greater attack rates compared to the general population.

The case fatality rate in Somalia at the same period was 1.5% nationally, but 4.2% in areas with limited access to care (UNICEF Somalia, 2022). Surveillance data from Mogadishu hospitals showed that 89% of measles cases admitted were not vaccinated, reflecting the wide gaps in routine vaccination coverage.

2.2 Management of Measles

Measles control is an important part of public health intervention, and the vaccine has become an important weapon in stopping outbreaks and lowering deaths caused by the disease. The measles vaccination helps prevent almost 2 million child deaths a year, is safe, and is very cost-effective, according to the World Health Organisation (WHO, 2013). There was a significant

78% drop in measles deaths around the world from 2000 to 2008 mainly because so many people were vaccinated (WHO, 2013).

It is also necessary for the measles vaccine to keep unprotected children and others with weak immunity safe and to protect the community against additional infections. Risk of measles transmission can be lowered and people who cannot be given vaccines can be protected if communities make sure a large number of people are immunised using regular programmes. Having this great immunity among the group protects populations and prevents outbreaks.

When either the measles or rubella are suspected, it is vital to quarantine and report to local health experts as soon as possible to avoid more cases. It is typical to use a number of tools for a proper diagnosis of these diseases. It is most effective to collect throat, nasal, and urine samples for viral detection. All of these samples are then tested for the presence of the virus using nucleic acid sequencing and polymerase chain reaction (PCR). Since measles and rubella have no known treatment at this time, blood samples are also taken for serological testing in order to evaluate the immunological response (WHO, 2013).

Since there is now no known cure for measles, treatment methods mostly aim at alleviating symptoms. For fever and pain, analgesics are usually given, and for subsequent bacterial infections, antibiotics could be recommended. Oral rehydration treatment is also essential for lowering fever and ensuring the patient's comfort (WHO, 2013).

In addition to vaccination campaigns, public health programmes stress the significance of measles and rubella monitoring and prompt action in the event of suspected cases. In order to stop the spread of the disease in communities, it is critical to identify affected people quickly, diagnose them, and isolate them. Containment operations rely heavily on thorough contact tracing and monitoring of possibly exposed persons. This enables targeted actions to restrict the spread of the virus.

Measles control measures must include medical treatments, but they must also include community involvement and education. Raising awareness about why vaccination is helpful in avoiding diseases is another objective of such initiatives. If health professionals address the issue of vaccine hesitancy, it can help them control diseases and raise the rates of vaccination. Management research on measles is helping to create new tools for diagnosis, design treatment plans and make vaccines. New molecular diagnostics such as fast point-of-care tests and handy antigen tests look very useful for detecting and managing measles outbreaks more effectively. Likewise, innovative antiviral drugs and additional treatments may help patients cope with diseases and lead to improved results.

An effective way to manage measles involves vaccination, monitoring, quick action, involvement of the community and endless research. Applying these methods in healthcare systems helps control and reduce impacts from measles and save many lives (WHO, 2013).

To successfully control and limit the consequences of this highly infectious viral illness, the treatment of measles involves a multi-faceted strategy that incorporates vaccination, public health initiatives, community participation, and constant research. Immunization is the main instrument in measles management, although there are other components to the approach as a whole, such as quarantine, treatment, education, and monitoring.

2.2.1 Campaigns and Strategies for Vaccination

The best way to avoid measles is to get a vaccine. It is common practice to provide the measles vaccination with the MMR vaccine, which protects against measles, mumps, and rubella all at once. It is suggested to provide the measles vaccination in two doses to achieve a strong protection. A normal interval between the first and second doses is 9–12 months, with the second dosage administered between 15–18 months. Because infants who do not get enough antibodies from their mothers and some children may not respond to the first dose are at risk, this schedule was set up (WHO, 2019).

2.2.2 The Global Initiative for Vaccination.

Thanks to the Measles & Rubella Initiative and similar worldwide immunization efforts, the number of measles deaths has dropped. One of these efforts is mass vaccination which aims to give more vaccines to communities that do not have easy access. Often, places involved in conflict, that have people displaced due to it and where caring for disease is difficult make up the objectives of these programs. The main objective of these organizations is to vaccinate as many as possible and end epidemics by increasing the protection of these groups.

2.2.3 Interventions in Public Health

Effective measures in public health are necessary to gain control over measles. It is through surveillance that measles cases can be spotted and reported as quickly as possible. During an epidemic, countries with strong monitoring systems are able to deal with the disease promptly. When there are suspected cases, they are checked in laboratories, epidemic trends are analysed to set vaccination plans and measles incidence is frequently reviewed (WHO, 2013).

2.2.4 Staying Separated from Others

To stop the spread of measles, anyone who are suspected of having the disease should be quarantined and isolated immediately. In order to reduce the spread of the virus, health officials must act quickly to identify affected persons and quarantine them. As part of this process, hospitals will need to establish isolation units and implement stringent measures to restrict the spread of infection among healthcare personnel. Importantly, contact tracing involves identifying and monitoring everyone who has been into touch with the infected person. If needed, they may be isolated to stop the spread of the disease (WHO, 2013).

2.2.5 Treatment of Symptoms

Since there is now no antiviral medication that may cure measles, the main goals of therapy are symptom relief and the avoidance of sequelae. As part of their supportive treatment, patients are encouraged to drink plenty of water using oral rehydration solutions, take fever-

reducing medications, and take vitamin A supplements to lower the chance of serious consequences including blindness. Pneumonia and otitis media are examples of secondary bacterial infections that may be treated with antibiotics (WHO, 2013).

2.2.6 Engaging with the Community and Educating Members

Measles control efforts can only be effective with the help of the community and their knowledge. It is imperative that public health campaigns tackle vaccination scepticism, debunk vaccine misconceptions, and highlight the vaccines' safety and effectiveness. Building trust and encouraging vaccination uptake may be achieved by engaging community leaders and influencers. Such programs should teach parents how the measles vaccine schedule works and how to spot the first signs of measles to act promptly (WHO, 2013).

2.2.7 Strategies for Integrated Management

Vaccination, supervision, treating infected individuals and raising knowledge are key points of a good strategy to stop measles. For effective control over measles epidemics, the healthcare system has to coordinate these efforts. To do this, people in affected communities should help fight the disease, healthcare should be accessible for treatment, good monitoring systems should be set up and vaccination should be carried out widely.

2.2.8 Recent Advancements in Treatment and Prevention

Recent developments in the treatment of measles have focused on increasingly vigorous therapeutic strategies and improved prevention strategies. Clinical guidelines on the treatment of 2022 were updated by the World Health Organization, with emphasis placed on early high-dose vitamin A supplementation in the first 24 hours of diagnosis, which resulted in a 50% reduction in mortality in children aged under two years (WHO, 2022).

Novel supportive care management interventions currently encompass the use of nebulized ribavirin in the treatment of complex pneumonia among immunocompromised children with excellent outcomes in reducing respiratory failure episodes (Martinez et al., 2023).

Additionally, the presence of measles-specific immunoglobulin therapy has improved management outcomes for high-risk individuals, particularly those with primary immunodeficiency diseases (Johnson & Smith, 2022).

Prevention strategies have been enhanced via the deployment of fractional-dose vaccine regimens in outbreak response to facilitate broader coverage in the event of constrained supplies of vaccines. One-fifth of the full dose of the measles vaccine has been shown to have 95% efficacy and expand vaccine supply by 500% as documented by research in Africa (Goodson et al., 2023). Moreover, digital immunization registries and mobile health technologies have improved monitoring of vaccination as well as removed missed opportunities for immunization in low-resource settings (Ahmed et al., 2022).

2.3 Global Control and Eradication of measles

Many insights learnt during polio elimination endeavours have helped with the control of measles. Moreover, the end of rinderpest infection, a comparative Morbillivirus of steers, shows the organic chance of measles destruction. The World Health Assembly (WHA) set out objectives for measles control in 2010 that were expected to be achieved by 2015. These goals encompassed attaining 90% coverage of the first dose of measles-containing vaccine (MCV1) at the public level and 80% coverage in all regions, decreasing measles incidence to fewer than 5 cases per million individuals, and achieving a 95% reduction in measles-related deaths compared to levels in 2000. In spite of colossal advancement, with an expected 20.3 million fatalities stayed away from by the measles antibody in the past 15 years, overall control endeavours have slacked, and the worldwide local area has failed to meet the WHA targets. In 2014, the estimated worldwide MCV1 coverage was 85 percent, and by 2015, only 61 percent of nations had achieved > 90 percent MCV1 coverage. On a global scale, there has been a noteworthy rise in the coverage of the second dose of measles-containing vaccine (MCV2), with six countries (Angola, Malawi, Mozambique, Nepal, Sierra Leone, and Zimbabwe)

instituting regular MCV2 schedules. This increase has raised the global MCV2 coverage to 61 percent (Coughlin et al., 2017).

Certainly, several challenges need addressing before measles eradication can be achieved. Foremost among these is the task of enhancing vaccination coverage across all countries, necessitating enhancements to public health infrastructure. Innovations in vaccine delivery methods will play a crucial role in achieving higher coverage rates. Additionally, the logistical challenge of maintaining the cold chain for measles vaccination presents a significant financial burden in many regions (Coughlin et al., 2017).

2.4 Overview of Vaccination Coverage

Vaccinations against measles, rubella, and mumps are often given together. This combined method, which keeps the MMR (measles, mumps, and rubella) vaccination safe and effective whether given alone or with additional vaccines, is known as the MMR vaccine. World Health Organization (WHO) research indicates that combining rubella with measles vaccination results in a slightly higher total cost. However, this is more than compensated for by shared delivery and administrative expenditures, making it a cost-effective approach (WHO, 2019).

It is difficult to understand the complicated dynamics of children vaccination uptake, especially in less developed countries. Although there has been great progress in reducing infant mortality rates due to immunization, over 20% of infants born in underdeveloped countries do not get all the necessary immunizations during their first year of life. This amounts to a large number of children. According to estimates made in 2007, 23 million infants and toddlers did not get the measles vaccination as part of their regular immunization schedule. Worryingly, only eight nations with very dense populations were home to over 15 million (or 65%) of these youngsters (Mohamed, 2015).

With 86% of the world's youngsters getting a measles vaccine via regular healthcare facilities in 2018, the worldwide reach of measles immunization has greatly increased. Improving

vaccination rates has been a worldwide priority, and this is evidence of that (WHO, 2019). The 2001 figure was 72%. In light of these advancements, it is nevertheless absolutely necessary to vaccinate children twice in order to provide full protection and avoid epidemics; around 15% of vaccinated children do not acquire immunity after the first course of vaccination. World Health Organization (2019) reports that there was an insufficient number of children vaccinated against measles in 2018. Specifically, 69% of children got their second dosage of the vaccine. The measles vaccination must be administered in two doses to ensure that all children have protection; otherwise, the vaccine will not work. A second dosage is usually given between fifteen and eighteen months of age, with the first dose being given at nine months or soon after. By spreading the vaccine in this two-dose regimen, we can reduce the likelihood of measles outbreaks and guarantee that almost all children will be vaccinated. An important public health problem is the large number of children who do not get the second dose of the measles vaccine. This poses a risk of disease outbreaks since these children are left susceptible to the illness (WHO, 2019).

A number of causes lead to children in impoverished nations not getting the vaccines they need. Among them include healthcare infrastructure gaps, inadequate financing for immunization programs, and logistical hurdles like reaching marginalized or faraway people. In addition, cultural and social variables including vaccine skepticism and false information regarding vaccine safety might impede attempts to obtain high immunization rates. In order to overcome these obstacles, it is necessary for local communities, international organizations, and governments to work together to enhance healthcare systems, increase vaccine accessibility, and educate the public on the advantages and risks of vaccination (Mohamed, 2015).

There has to be a concerted effort to include vaccination programs into larger health services in order to increase the coverage of measles vaccines. Vaccines may be administered at regular checkups by taking advantage of programs like school-based vaccination campaigns and child

health days. To increase the number of children who get the recommended doses of measles vaccine, nations may improve the effectiveness and accessibility of their immunization programs by incorporating it into preexisting health services (WHO, 2019).

Public health interventions such as the measles vaccination, whether given alone or in conjunction with the rubella and mumps vaccines, have been vital in reducing deaths caused by measles on a global scale. Making sure all children get the necessary two doses to be fully protected is still very important, even though we've come a long way in raising vaccine coverage, especially for the first dose. Developing nations have a serious problem with vaccine uptake, and a solution is to improve healthcare infrastructure, raise public knowledge, and include vaccination into other health services. Further reduction of the measles burden and protection of children's health across the world are both achievable via these combined efforts.

2.5 Attitude towards Immunization

Mothers' and carers' decision-making process when it comes to children immunisation is influenced by a complex interplay of socio-economic, geographical, and institutional variables. Vaccination uptake is impacted by trust, which is more important than distance or waiting periods. Parental choices are heavily influenced by their level of trust in healthcare practitioners and the accuracy of vaccination information. This emphasises the significance of methods that promote effective communication and community participation (Mohamed, 2015).

Also, vaccination habits are greatly influenced by people's socioeconomic status. In spite of practical hurdles, families with more disposable money and more secure employment may be better equipped to put their children's preventative healthcare needs first. On the other side, economic hardship may disproportionately affect marginalised populations, making it even more difficult for them to receive vaccination services and widening the gap in immunisation coverage.

Resolving immunisation disparities is a critical function of healthcare infrastructure. Immunisation services are accessible to varying degrees depending on factors such as the location of healthcare institutions, the availability of qualified personnel, and the effectiveness of vaccine distribution networks. Equal access to vaccinations and the reduction of gaps in vaccination coverage among communities can only be achieved via investments in healthcare infrastructure, especially in underprivileged regions.

Cultural and societal variables can have a role in vaccination coverage rates. Vaccination acceptability and uptake may be influenced by community norms, beliefs, and attitudes. Immunisation programmes may be more successful and build faith in healthcare systems if they are tailored to local traditions and beliefs, and if they encourage community involvement and ownership.

To sum up, removing obstacles to vaccine access calls for a holistic strategy that takes into account the complex relationship between cultural, institutional, geographical, and socioeconomic variables. Policymakers and healthcare practitioners may better safeguard children's health and well-being by increasing vaccination coverage and gaining a better knowledge of the numerous factors that influence vaccination behaviour.

2.6. Socio-Demographic Factors

2.6.1. Age and Sex of the Child

People get vaccinated at various intervals throughout their lives, most often between the ages of one and five. Child variables such as age and gender may also impact vaccine uptake. Devendra Kumar *et al.* (2009) discovered that completely vaccinated youngsters were mostly male. Girls were less likely than boys to get a full vaccination, and they were more likely to be unimmunized or only partly vaccinated.

Other researchers, such as Simons *et al*. (2012), established that the impact of a child's age on inoculation status is probably going to rely upon whether the youngster had early contact with "health" administrations and, furthermore, on the transient impact of mass immunization crusades, which might have been more viable in unambiguous years. The gender of the child and the age of the mother may also impact the chance of immunization (WHO, 2013). In communities where gender inequality is common, studies have revealed that a child's sex may predict the child's vaccination status. A study done in India from 1996 to 2006 found that females had a much lower vaccination rate than boys for BCG, DPT, and measles (WHO, 2013).

2.6.2. Socioeconomic Status (SES)

Individuals and families' socioeconomic status (SES) greatly affects their access to vaccination and other health outcomes since it determines the opportunities and resources accessible to them. Socioeconomic status (SES) is a complex concept that includes several factors, including income, level of education, and occupation. All of these factors influence whether or not a person or family can afford to get the immunizations they need (Simons et al., 2012).

The amount of money a family has to cover healthcare depends greatly on their economic situation. Some low-income families may not be able to get medical care because vaccines and other preventive treatments are too expensive for them. Their lack of money for transportation often prevents these families from getting medical aid for their children and immunizations not supported by the government. Since vaccines may not be very costly, families can still face the challenge of paying for them, so children are not able to get attention when needed (Simons et al., 2012). In addition, families in impoverished areas struggle to put vaccine care first because they face a lack of inexpensive healthcare which makes the situation worse.

When it comes to factors influencing health, education is the biggest part of socioeconomic status (SES). Most people with higher education can find and evaluate health information and

this means they have better health literacy. It is often the case that a lack of education among people is tied to poor health literacy in communities. Because of this knowledge gap, it is possible that more people are hesitant about vaccines and less interested in getting involved in vaccination campaigns (Simons et al., 2012). Reaching high vaccine numbers among uneducated people is difficult as they are often provided false information about vaccines.

How healthy people are is affected by their economic situation which is determined by the type of work or occupation. Regular earnings and insurance for vaccines are benefits that one can enjoy with a stable job. Compared to insured people, it is more expensive for those who do not have health insurance or who make little and do not have job perks to get themselves immunized (Simons et al., 2012). A person's ability to manage their healthcare can be affected by whether or not they have a job. People who are in danger of job loss might find it tough to arrange time off to see a doctor and therefore might not be able to get vaccinated.

Income, education and employment are all parts of socioeconomic status that have a significant effect on vaccination among children from low-income groups. Because fewer vaccinations are given to these children, they may suffer more from diseases that could be prevented by vaccines. Having to bear large healthcare costs, not having enough mobility and lacking health knowledge are some examples of barriers that stand in the way of equal access to healthcare (Simons et al., 2012).

Treatments that pay attention to society's diversity are needed to deal with unequal vaccination rates. Offering financial help to low-income families in the form of transport and vaccination subsidies, among other similar efforts, can lower some of the obstacles they face (Simons et al., 2012). It is also necessary for areas with less education to include programs that help people learn more about health and dispel false beliefs about vaccines. This kind of advertising should consider the culture and demands of the target market.

Healthcare should also be brought to communities that are usually disadvantaged. Working with community health groups and mobile clinics makes it simpler for people who cannot easily get to a vaccination site due to transportation challenges. Also, research conducted by Simons et al. (2012) suggests that the vaccination rate among low-income groups can improve a lot if vaccines are offered for free by public health programs.

2.6.3. Geographic Accessibility

If healthcare facilities for immunisation are located near the people who require it, then one can describe this as geographical accessibility. People living in rural and distant areas may find it tough to use immunisation services because there are not enough health facilities and transport options available Simons et al. (2012). It is often hard for families who do not have their own transport to visit centres that give immunisations, due to distance and cost. For this reason, vaccinations are less common among remote communities which increases their chances of getting unfamiliar diseases.

2.6.3 Cultural and Social Norms:

Community values, beliefs and standard behaviours strongly shape people's acceptance of and use of vaccines. The way parents think about vaccination can be affected by their cultural perspective on illness, religious beliefs and traditional approaches to wellness (Kisangu et al.,2016). There are cases where groups avoid vaccines, believing wrong information about their safety and effectiveness that other people have said. Vaccine acceptance can also be reduced by views on vaccination found in the community and these may stem from previous experiences or doubts about healthcare organizations. Building relationships, clearing up false assumptions and raising confidence in vaccines are some of the social and cultural elements that address why people correspond to vaccine acceptance (Kisangu et al., 2016). It is possible by engaging local people, using methods that fit their culture and joining forces with reputable

community leaders and influencers. They may achieve this by resolving any obstacles to vaccinations that are set by society and culture.

2.7. Cases of under five children diagnosed with measles

From 2003 to 2016, Kisangu *et al*. (2016) studied Kenya's progress toward measles eradication from 2003 to 2016. From January 2003 to December 2016, a sum of 26,188 thought measles cases was accounted for by means of Kenya's public measles case-based checking framework, as per the scientists.

Among the total cases, 9,043 (35%) were confirmed as measles cases, including 3,423 (38%) laboratory-confirmed cases, 4,856 (54%) epidemiologically associated cases, and 764 (8%) clinically diagnosed cases. The proportion of discarded cases remained consistent over time, particularly during epidemics. Over a 14-year period, the total incidence was more than 5 cases per million people, with a yearly incidence ranging from 2–65 cases per million people. There were no measurably massive contrasts in the event of measles between sexes. The biggest frequency rates were among infants matured one year (generally: 76; territory: 1-349) and children matured one to four years (by and large: 55; territory: 0.1-364), as well as among those living in urban areas (generally speaking: 118; territory: 3-886). Inclusion with single dosage of MCV varied from 20% to 77% among confirmed cases; altogether, only 3,069 (34%) of patients had received one or more doses. During the research period, 3,316 patients (36 percent) were hospitalised, and 165 fatalities were documented (case fatality rate of 1.8 percent).

Endriyes et al. (2018) looked into measles in Ethiopia's Southern Nations Nationalities and People's Region between July 2013 and January 2014. They found 2,132 cases, both confirmed and suspected. The researchers checked vaccination records and how long people waited to see a doctor after symptoms started. Measles tests confirmed only 94 cases (4.4%). The rest were identified as measles based on other factors. The study found no difference in the number of cases between males and females. The majority of cases, 1,204 (56.47%), were aged between

5 and 14 years, with a median age of 8.00 (interquartile range 3.0, 12.0). By far most of patients, 1787 (83.8 percent), were not hospitalized or treated in a short term division. Just a single casualty was reported because of treatment. Affirmation rates for the two genders were comparatively generally equivalent, with a sex proportion of 1.03 (guys to females). The greater part of the cases, 1319 (61.9 percent), had gotten something like one portion of the measles immunization, with 49.5 percent being female. Around one-fourth of the cases, 535 (25.1%), were vaccinated with at least two portions of the measles antibody through standard or potentially extra inoculation programs. Around one-fifth of the patients, 398 (18.7%), were unvaccinated, while the immunization status of 415 (19.5%) was muddled. In something like 48 hours of the initiation of signs and side effects, close to two-fifths of the 846 cases (33.9 percent) went to a "health facility". Male and female medical services looking for conduct was almost indistinguishable; 433 (40.4%) males and 413 (38.9%) females visited medical services offices in somewhere around 48 hours of sickness onset.120 (14.2%) of the individuals who visited a "health" office before 48 hours were conceded, while 225 (17.5%) of the people who visited a "health" office following 48 hours were hospitalized. The typical postpone time was two days (IQR 1.0 to 3.0).

2.8 Measles deaths among children under five years of age

Wong *et al*. (2019) conducted research to investigate the effect of measles vaccination programmes in India, stating that from 2005 to 2013, the Million Death Study documented fatalities for 13,490 young ladies and 13,007 young men matured 1-59 months in the wake of killing youngsters who passed on from obscure causes (2.8 percent). As indicated by the basis of at least one doctor codes or the family revealed a measles history for the dead, 79% of the 1,638 measles fatalities happened in country regions, 73% in crusade states, 59% at ages 12-59 months, and 57 percent in females.39 percent of the dead childrenhad somewhere around one portion of measles inoculation, regardless of the way that 76% of families announcing a

measles demise detailed the youngster had a past filled with measles (utilizing the neighbourhood language word). From 2005-2009 to 2010-2013, the level of measles mortality at 1-59 months expanded imperceptibly (34% to 47 percent) in crusade states revealing no less than one portion of measles inoculation, however remained for the most part stable in non-crusade states (48% to 51 months increased marginally (34 percent to 47 percent) in campaign states reporting at least one dose of measles vaccination, but remained mostly stable in non-campaign states (48 percent to 51 percent). Verbal autopsies can be inaccurate, but the percentage of people who died who had been vaccinated against measles didn't change between different case definitions. This means that doctors weren't more likely to assign death to people who had been vaccinated against measles than people who hadn't been vaccinated.

From 2005 to 2013, the yearly number of measles-related deaths among children aged one to 59 months dropped from 62,000 to 24,000. Prior to the campaign's launch, 76% of these deaths happened in states covered by the campaign, with Uttar Pradesh, Madhya Pradesh, Rajasthan, and Bihar collectively accounting for 55% of them (18%, 15%, 11%, and 11% respectively). Following the program's initiation, 59% of measles-related deaths occurred in campaign states, with 38% of them taking place in the aforementioned four states. The age conveyances didn't change altogether among when the mission. During this time, the measles death rate per thousand live new-borns fell fundamentally. Over the entire exploration time frame, the typical yearly pace of decrease (AARR) in measles mortality was 12%, however this expanded to 22 percent after the mission began. Measles mortality declined 27% faster in campaign states compared to non-campaign states (11%). The average annual reduction rate (AARR) decreased most significantly in campaign states (15%), with notable declines observed in Madhya Pradesh (20%), Uttar Pradesh (19%), Rajasthan (17%), Chhattisgarh (17%), and Gujarat (17%) as well (14%).

A study by Li et al. (2013) looked at how measles cases and deaths changed in Beijing, China, over 60 years (1951-2011). They found a dramatic decrease. Measles cases per 100,000 people went down from nearly 600 in 1951 to just half a person in 2011. Measles deaths followed a similar pattern, dropping from almost 48 per 100,000 people in 1951 to none in 2011. This suggests a major improvement in measles control in Beijing over that time period. From 1951 to 1965, measles incidence varied between 390.7 per 100,000 populations and 2721.0 per 100,000 populations. An increase in incidence was noted every 2–3 years. The death rate for measles ranged from 2.5/100,000 to 48.4/100,000. From 1966 to 1977, the incidence ranged from 32.2/100,000 to 397.1/100.000, representing a 92.7 percent reduction from the pre-vaccination level. There was a 3–4 year recurring periodic pattern. The mortality rate has dropped dramatically to 0.1-1.5/100,000 people. In the period 1978–1996, there were two periods of change in incidence. Prior to 1985, the average incidence was 78.7/100,000 people. Since 1986, the frequency of measles has been quite low, with most years seeing fewer than 2 per 100,000 people infected. From 1986 through 1996, no measles fatalities were documented. Between 1997 and 2004, the incidence ranged between 0.7 and 6.6 per 100,000 people. Between 2005 and 2011, the incidence increased from 6.6/100,000 to 24.5/100,000. Following the MV SIAs in 2010, the incidence fell to 0.5/100,000 in 2011. Between 1997 and 2011, four fatalities were recorded.

2.9 Vaccination status of children under five years of age with measles

The study by Sani et al. (2016) identified a worrying trend of measles in Kwangwara Town, Nigeria, specifically among young children. Their findings showed that out of 111 measles cases, a high percentage (81.2%, or 95 children) lacked proper vaccination. This highlights the importance of childhood measles vaccinations. Even more concerning, nearly half (47.4% or 45 children) of the unvaccinated cases were new-borns, and a significant portion (60% or 27 children) were under 9 months old, raising questions about measles exposure in these very

young infants. A study in Kwangwara Town, Nigeria, by Sani et al. (2016) found a high number of measles cases in young children. Even among those with measles, a significant number (81.2%) had not been vaccinated. This suggests a need for improved vaccination rates. There were also concerns about measles exposure in very young infants, as nearly half (47.4%) of the unvaccinated cases were new-borns, and a significant portion (60%) were under 9 months old. A measles outbreak investigation in Abaya, Ethiopia by Ketema et al. (2013) found that 61% of measles cases had not been vaccinated. This is despite a reported vaccination coverage of 87%. Among children aged 1 to 15, a period where high vaccine coverage is expected, 46% had not been vaccinated. The biggest number of unvaccinated patients were recorded from LedoKebele. Among those who caught measles, 61 percent hadn't received any measles vaccination. Additionally, 46 percent of patients aged 1 to 15 years, a period with anticipated high vaccine coverage, were found to be unvaccinated. There were 398 people who hadn't been vaccinated, and 415 people who didn't know whether they had been vaccinated or not. Within 48 hours of the beginning of signs and symptoms, about one-fifth of the patients, or 846 (39.7 percent), attended a health facility. Male and female health-care seeking behaviour was nearly comparable; 433 (40.4 percent) of males and 413 (38.9%) of females visited a health-care institution within 48 hours of becoming ill.

2.10 Association of vaccination status and measles mortality

A study by Higgins et al. (2016) reviewed research on the connection between childhood mortality and three vaccines: BCG, DTP, and measles-containing vaccines. They looked at several types of studies, including randomized controlled trials, cohort studies, and case-control studies. Specifically, they focused on 29 studies that compared the death rates of children who received the measles-containing vaccine to those who hadn't. The results of these studies showed that children who had received MCV were less likely to die from measles. Seven cohort studies were excluded from the meta-analyses due to being assessed as having a very high risk

of bias. Additionally, in three clinical studies conducted in Guinea-Bissau, the follow-up period was limited to nine months. At that time, children who were a part of the control group were given MCV. Because of the limited time for follow-up, there were a very small number of fatalities, and the results were equivocal. The directions of impact in these studies, as well as in a fourth clinical study that was conducted in Nigeria, indicated a favourable effect of receiving MCV (relative risk 0.74, ranging from 0.51 to 1.07; I2 = 0%). The findings from the 18 observational studies that remained consistent across estimations suggested a link between measles-containing vaccines (MCV) and reduced mortality within the first two to five years of life. On average, there was a halving of the mortality risk, with a relative risk of 0.51 (95% confidence interval: 0.42 to 0.63; I2 = 64%). We judged that there was a significant possibility of bias in each of these investigations. When we tried many alternative statistical approaches, the results did not significantly shift in any way. Upon excluding or censoring fatalities attributed to measles, the results indicated that the observed effects, if genuine, were not solely accounted for by deaths directly caused by measles.

2.11 Theoretical Framework

This study applies a number of theoretical frameworks to explain the complex dynamics of measles vaccination behaviour and epidemiology among children under five years in Mogadishu hospitals.

2.11.1 Health Belief Model (HBM)

The Health Belief Model provides a foundation framework to be familiar with vaccination behaviour among caregivers. HBM posits that four constructs dictate health-related choices: perceived susceptibility (perceptions among caregivers that their child would develop measles), perceived severity (perceptions of measles complications and how threatening they are), perceived benefits (perceptions of vaccine efficacy), and perceived barriers (challenges to

vaccination such as cost, access, or safety concerns) (Rosenstock, 1974; Champion & Skinner, 2008).

In the study context, HBM provides an explanation of why some children are not being vaccinated even when services are available. High perceived barriers or low perceived susceptibility can lead to vaccination hesitation, and consequently, higher measles incidence among unvaccinated children.

2.11.2 Social Determinants of Health Framework

The Social Determinants of Health approach highlights the ways in which socioeconomic status, levels of education, geographic accessibility, and cultural context affect health outcomes (WHO, 2010). This approach is most relevant in conflict-affected environments such as Somalia, where structural determinants like healthcare infrastructure, socioeconomic status, and displacement greatly affect vaccination rates and measles epidemiology. The model describes the interplay between socio-demographic factors (socioeconomic status, gender, age) and factors within health care systems that together determine vaccination acceptance and its effects upon measles morbidity in children.

2.11.3 Theory of Planned Behaviour (TPB)

TPB accounts for vaccination decisions through three factors: attitudes towards vaccination, subjective norms (social and cultural perceptions), and perceived behavior control (self-esteem in seeking the services) (Ajzen, 1991). Theory explains how the beliefs of the community, the recommendations of medical practitioners, and perceived ability to obtain the services influence vaccination intentions and behaviours.

2.11.4 Framework Application to the Study Context

The integrated theoretical framework explains how vaccination status serves as the central mediating variable that connects socio-demographic factors with measles outcome. The unvaccinated children, conditioned by HBM barriers and social determinants, experience

higher rates of measles incidence and possibly dangerous clinical outcomes. Conversely, vaccinated children, with the benefit of protective immunity, experience lower rates of incidence and favourable outcomes.

It guides epidemiological data analysis by providing theoretical underpinning to observed associations between measles mortality and vaccine status, as well as the effects of socio-demographic factors on coverage and health outcomes.

2.12 Conceptual Framework

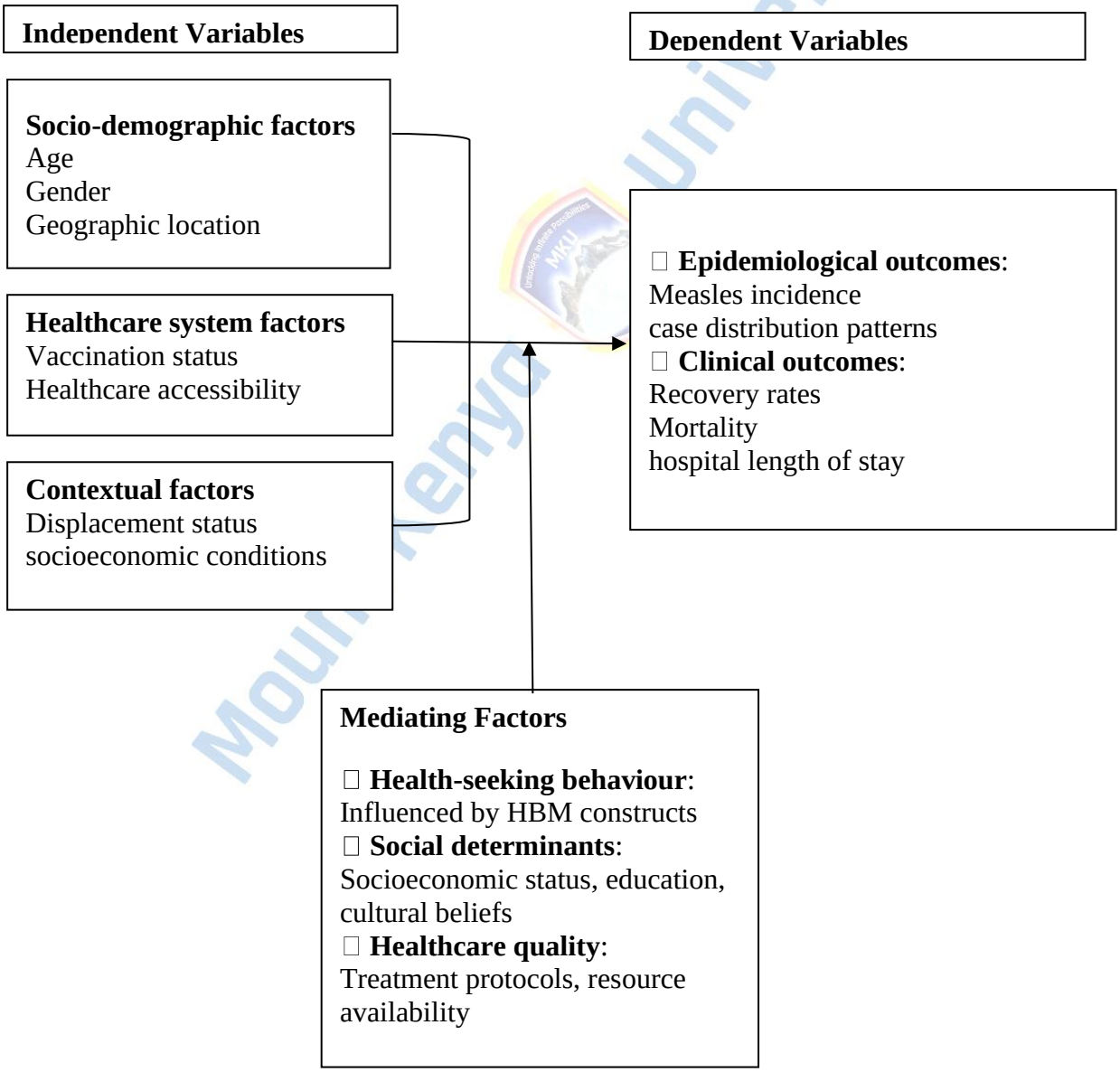

Figure 1: Conceptual Framework (Researcher 2021)

The framework places socio-demographic variables (age, gender, socioeconomic status, geographic accessibility) as core determinants that act on the vaccination status - the main mediating variable. These demographic features result in disparities in access to immunization services, such that younger children (especially 1-2 years) and disadvantaged children have more obstacles to vaccination coverage.

The key pathway between background factors and health outcomes is provided by vaccination status. The framework proves that children who are not vaccinated due to the impact of socio-demographic barriers revealed under the Health Belief Model and Social Determinants of Health approaches have an increased number of measles cases and possibly worse clinical outcomes.

The strength of the framework is in demonstrating that epidemiological data covers all these variables and involves the complex interrelation between demographic trends, vaccination coverage disparities, and the burden of disease. The results of the current study - 95.5 percent of all hospitalized cases were unvaccinated, the age group of 1-2 years old had the highest disease burden - confirm this conceptual relationship, showing how demographic vulnerabilities are converted into vaccination gaps, which finally led to measles hospitalization and different clinical outcomes.

2.13 Summary of Literature Review

Measles is a highly infectious virus that transmits from person to person by respiratory droplets. Vaccination programmes have made great strides, but measles is still a major problem in developing countries, especially in Asia and Africa. Estimates put the number of measles infections worldwide at 9.7 million in 2015, with 254,928 confirmed cases across all six WHO regions.

Measles vaccine has played a crucial role in averting millions of fatalities around the globe. The measles vaccination reduced measles-related fatalities by an astounding 78% worldwide

from 2000 to 2008, averting the lives of over 2 million infants each year. The significance of measles management was acknowledged by the World Health Assembly (WHA), which set ambitious goals to be accomplished by 2015.

One estimate puts the number of infants benefited by immunisation at 2.5 million annually, highlighting the critical role that immunisation programmes play in preventing preventable deaths. Nonetheless, many babies in underdeveloped nations still do not get the shots they need after a year of life, even if there have been some achievements. According to the World Health Organisation, getting the measles vaccination twice is the best way to protect yourself and others against the disease.

Findings from studies done in India showed that immunisation rates differed across sexes, with females showing far lower coverage for vaccinations including measles, BCG, and DPT (WHO, 2013). Incidence rates were greatest in metropolitan areas, in children aged one to four, and among neonates less than one-year-old. Children between the ages of 5 and 14 accounted for an alarming majority of the cases recorded.

In order to manage measles infections and reduce fatality rates, it is vital for people to seek healthcare early on. Though symptoms began within 48 hours, just one-third of patients sought medical attention within that time frame. Even though there was an attempt to vaccinate children against measles, many of the children who died had already taken the vaccine. Still, measles death rates have dropped dramatically, with a 27% quicker drop in states that ran vaccine programmes compared to those that didn't.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the approach used in reviewing and analysing measles data among children under five years old treated in Mogadishu hospitals from 2020 to 2022. The approach included the step-by-step process used to handle the research's objectives and respond to specific questions.

This part of the paper discusses the research design, identify the variables, explain where the study was done, give a description of its setting, define the target audience and establish which people were included and excluded from the study. It explains how statistical calculations were used to determine sample size, describes the ways of selecting participants for sampling and lists the collecting tools for gathering the data.

Besides, the chapter describes the methods of gathering data, analysing the results, maintaining quality in research and following ethical standards for proper conduct of studies. This way of implementing methodology enables the reliable and valid use of data in understanding measles spread in the study area.

3.2 Research Design

The data analysis looked at the results of a descriptive epidemiological study carried out in Mogadishu hospitals for children under five years old between 2020 and 2022. The researcher chose this method based on different aspects of methodology. Through this design, one may swiftly find out how common a disease is and why in the medical records of an area or nation at a set moment, so it is optimal for epidemiological studies (Setia, 2016). By using a retrospective design, more complete data was gathered in the full three-year period and this could be achieved without needing as many resources or working in the field for a very long time.

Advantages of Chosen Design

The chosen retrospective descriptive cross-sectional design possesses several advantages for this study setting. It provides a general description of measles epidemiology in a key period, facilitates effective scrutiny of large databases, saves on costs and time requirements, and allows data availability without waiting for delayed outcome creation. The design is also particularly well-suited to generating baseline epidemiological data that could be utilized in informing intervention policy and strategy in the future.

Alternative Research Designs Considered

Other research designs had been contemplated but were deemed inappropriate to this study environment:

Longitudinal Study Design: While a longitudinal study would provide data regarding the temporal trend of measles occurrence and the persistence of vaccine protection, this was not feasible under the situation with the available resources, longer follow-up needed, and challenges for keeping participants engaged in a conflict zone. In addition, the research objectives were aimed at reporting epidemiological patterns and not tracking temporal trends in the cases.

Case-Control Study Design: While a case-control study might better assess some of the risk factors for measles infection by contrast between cases and controls matched on certain determinants, this type of study design was avoided since the primary objective was to define the overall epidemiological context rather than establish causal relationships. Moreover, accessing valid controls within the inpatient setting would have resulted in the introduction of selection bias.

Mixed-Methods Approach: A mixed-methods study combining qualitative interviewing could contribute to the findings on parental attitudes toward vaccination and healthcare-seeking behaviour. This avenue was not pursued because of logistical issues, ethical issues involved in

interviewing parents whose children are critically ill, and the quantitative epidemiological analysis orientation of the study rather than behavioural inquiry.

Prospective Cross-Sectional Design: While prospective data collection would ensure better quality and completeness of the data, this design was not feasible given the duration of the study and could not capture the historical epidemiological trends during 2020-2022, where COVID-19 brought drastic disturbances in healthcare.

3.3 Research Variables

3.3.1 Dependent variable

Evaluation of the dependent variable, which concerned better measles care in a particularly susceptible population—children less than five—was the primary focus of the research. In order to determine this, the researchers painstakingly reviewed the data of measles cases within this age range from 2020 to 2022. The success of initiatives targeted at improving measles management within this crucial demographic segment was illuminated by this detailed study, which included the efficacy and impact of any interventions or adjustments performed throughout this era.

3.3.2 Independent variables

A number of important elements that shape the measles management landscape were included as independent variables. One of the key factors in determining the immunity level among the population under research was the vaccination status, which was classified as either vaccinated or unvaccinated. The distribution and frequency of measles among the target population might be better understood by looking at the disease's status, which was categorised into confirmed cases and suspected cases. In addition, the effectiveness of treatments and healthcare measures in reducing the impact of measles was mostly determined by the outcomes: recovery or death. The study's overarching goal was to help public health officials make better decisions and

design more effective policies for measles treatment for children younger than five by thoroughly examining these independent factors.

3.4 Study site and area

Researchers in Mogadishu, Somalia, namely in the Banadir area, carried out the research. Understanding public health dynamics, especially in relation to communicable illnesses, requires a thorough examination of Mogadishu, the country's capital and biggest metropolitan region. With an estimated population of over 2.5 million, the city has a highly crowded metropolitan core that faces substantial public health issues.

Population and Demographics

Mogadishu is home to people from all walks of life and all corners of the globe. Because of persistent war, migration, and economic reasons, the city's demographics have changed dramatically throughout the years. Internally displaced individuals (IDPs) make up a large chunk of the population; they've escaped instability and violence in other regions of the nation. A large number of these internally displaced people call one of the city's many informal settlements home. Living conditions are poor and illness susceptibility is high in these communities because of the absence of essential infrastructure.

Medical Facility System

Many obstacles stand in the way of Mogadishu's healthcare infrastructure. There are a lot of people in need of medical care, and the hospitals in the area, including Banadir, SOS, Hamar-jajab District, and Daynile, are often at capacity. The city's citizens, notably the enormous number of internally displaced persons (IDPs), rely on these facilities for healthcare. However, hospitals face challenges due to limited resources, such as insufficient personnel, obsolete equipment, and a lack of medical supplies.

Dangers Facing Public Health

Overcrowding in internally displaced person (IDP) camps and informal settlements in Mogadishu contributes to the city's already high rates of infectious illness. Overcrowding and poor air quality contribute to the high prevalence of respiratory tract infections, both in the upper and lower respiratory tracts. Inadequate sanitation and hygiene facilities can lead to a high prevalence of skin illnesses. Unsafe drinking water and inadequate sanitation facilities are often associated with acute watery diarrhea, another important health problem. The already-shaky healthcare system is making matters worse by failing to provide sufficient treatment and preventative measures, adding insult to injury.

Temporarily Relocated Individuals

Particular difficulties are encountered by the Mogadishu-based internally displaced people. The loss of one's location of employment, social connections, and access to essential services is a common consequence of displacement. Internally displaced people (IDPs) deal with overcrowding, poor sanitation, and lack of potable water on a daily basis. Displaced people are more likely to get contagious illnesses because of these causes. Displacement also has psychological effects, like as stress and trauma, which may have a negative effect on health.

Collaborating with Government and Non-Governmental Organizations

The public health issues in Mogadishu are being tackled by a range of governmental and non-governmental organizations (NGOs). Healthcare, sanitation, and disease prevention are all areas that these groups strive to improve. The healthcare system has been undergoing reforms, capacity building, and infrastructure development by the government and foreign partners. In order to provide healthcare to underprivileged communities, especially in locations like refugee camps and rural areas, non-governmental organizations (NGOs) are vital.

3.5 Study Setting

An important background against which the research took place, the study location was carefully selected to include a wide range of healthcare services located in the dynamic

metropolitan environment of Mogadishu. Notable hospitals known for their dedication to serving locals with comprehensive healthcare services were among the institutions hand-picked with great care. One of them was the highly regarded SOS Hospital, a symbol of healing and hope for the community, providing a range of preventative and curative healthcare services to people of all ages.

The research also included the esteemed Hamar-jajab District Hospital, which is well-known in the area for its commitment to providing excellent treatment to those in need. This institution, with its many trained medical professionals and cutting-edge equipment, became an important hub for the study, shedding light on the epidemiology of measles in children younger than five. In addition, the research was conducted at the highly regarded Daynile Hospital, which is well-known for its extensive community health promotion initiatives. This institution, which is at the centre of healthcare innovation, was essential in developing the study narrative by providing unique insights into the local context of measles prevalence and treatment.

Lastly, the research included the highly regarded Banadir Maternity and Child Hospital, which is known for its exceptional maternity and child healthcare, its dedication to improving the health of mothers and their children, and its caring care for both. Measles epidemiology in children less than five years old was greatly aided by this hospital's extensive array of services, which included prenatal care, birthing, and paediatric treatment.

The research unfolded against a rich tapestry provided by the study setting, which consisted of a carefully selected group of Mogadishu hospitals. This provided a multifaceted lens through which the complex interplay of factors influencing measles epidemiology and community management could be examined. This study aimed to improve our knowledge of measles prevalence and to inform interventions based on evidence to protect vulnerable populations in the ever-changing urban environment of Mogadishu. It was a joint effort of these prestigious institutions and their committed healthcare professionals.

3.6 Target Population

For this research, special care was taken to gather data from children younger than five years who were brought to prestigious hospitals in Mogadishu because of measles. This group consists of people who must deal with the immense challenge of stopping measles in the ever-changing city of Mogadishu from 2020 to 2022.

Measles seriously harms young children. This research mainly looks at young children under the age of five since they are highly prone to measles and its effects.

The goal of this study is to study the management and details of measles in a certain group of people by examining the cases of children admitted to Mogadishu hospitals after measles was discovered. The main aim of the study is to find out which variable aspects cause more illnesses, better or worse treatment and different use of healthcare in this group by going through all the hospital data for the selected period.

Essentially, the study includes more than numbers; it displays the challenges that children under five deal with during the measles epidemic in Mogadishu.

3.7 Exclusion and Inclusion Criteria

3.7.1 Inclusion criteria

The study included children under 5 years old diagnosed with measles and admitted to hospitals during the period of 2020-2022.

3.7.2 Exclusion Criteria

Those under the age of five who were treated for measles at the hospital after 2020 were not considered by the study. The researcher investigated the spread and management of measles among children who suffered from it. As a result, the study group would all be similar which would lessen potential issues from confounding.

The study made the effort not to include prosecution records that were incomplete or missing anything. Strict rules were applied to collect only meaningful and well-detailed account of

measles cases, since it is essential to gather precise information. The researcher excluded partially completed data in our study because they did not provide information on patient demographics, if they were vaccinated and the course of their disease. Looking out for missing data and mismatches, the researcher tried to fix biases and improve the study's conclusions.

3.8 Sample Size

The author used Slovin's formula to determine the sample size.

n = N / (1 + Ne2)

Where:

n = Number of samples,

N = Total population and

e = Error tolerance (level).

Further, taking into consideration data from United Nations Assistance Mission in Somalia (UNSOM) in their immunization campaign against measles and polio in 2020 in Banadir region. the total population of the children under five years was 492,000 in all the 17 districts of Mogadishu, this is the total population. (UNSOM, 2020)

Therefore: N= 492,000

e = 0.05

e^2 = 0.05 *0.05 = 0.0025

Ne^2 = 492,000 * 0.0025 = 1230

1 + Ne^2 = 1 + 1230 = 1231

N/1+ Ne^2 = 492,000/ 1231

n = 399.675

And the value of n from the Calculation hereunder then becomes:

$$n = \frac{N}{1 + Ne^2}$$

$$n = \frac{492{,}000}{1 + 492{,}000 * 0.0025}$$

n= 399.675= 400

Slovin's formula was applied rather than other formulas because of a variety of considerations. Unlike power analysis calculations involving earlier effect size estimates unavailable in the current study context, Slovin's formula is appropriate for establishing tolerable sample sizes for descriptive studies from finite population parameters (Yamane, 1967). Slovin's formula was chosen over Cochran's formula since it allows for finite population correction that is appropriate when one already knows the population size. In addition, Slovin's formula is designed for cross-sectional prevalence and proportion descriptive studies rather than hypothesis testing studies requiring sophisticated power calculations.

3.9 Sampling Technique

Purposive sampling technique was employed in the selection of patient records from Banadir's four hospitals, SOS, Hamar-jajab District, and Daynile hospitals. This was a non-probability sampling technique based on its potential to enable purposeful selection of information-rich cases that meet specific criteria crucial for the attainment of research objectives (Patton, 2015). The approach was suitable for the retrieval of medical records with extensive measles case documentation in the most critical pediatric facilities.

3.10 Data Collection Instruments

Structured line list was the primary data collection instrument, and it gathered patient information (age, gender), clinical information (admission date, diagnosis), vaccination status, and outcomes. The instrument was designed to elicit standard information from medical records in a systematic way.

3.10.1 Pre-Testing and Data Collection

Pre-test was carried out in Medina Hospital, Mogadishu, on 20 measles case records of the year 2019 (outside the study period). Pre-test determined if the line list could capture full data from

medical records and points of challenge in extraction. Results demonstrated variability of documentation formats of vaccination status between hospitals, which resulted in standardization of extraction criteria. Pre-test also determined ideal time use (15 minutes per record) and refined data collector training procedures.

3.11 Data Collection Procedure

Data Extraction Process

Medical charts were systematically reviewed according to standardized protocols. Data collection included a complete review of patient charts, laboratory results, and discharge summaries for 2020-2022.

Missing Data Management

Missing data was addressed using a number of approaches:

Incomplete vaccination records: Patients with unclear vaccination status were cross-referenced with immunization cards and caregiver interview if present

Missing demographic information: Age was estimated by application of admission dates and documented birth dates when precise ages were unknown

Outcome data: Missing outcome cases were not used in mortality analysis but retained for incidence calculation

Documentation standards: Final analysis used only records containing complete core variables (age, gender, diagnosis, outcome).

3.12 Data processing and analysis

3.12.1 Data Management

Step-by-Step Data Management Process

Step 1: Data Entry

- Extracted data was entered into SPSS version 20 database

- Double-entry verification performed for 20% of records
- Data entry errors were identified and corrected immediately

Step 2: Data Cleaning

- Range checks performed for age variables (0-5 years)
- Logical consistency checks for vaccination dates and admission dates
- Missing data patterns were identified and documented

Step 3: Data Coding

- Gender coded as 1=Male, 2=Female
- Age grouped into five categories (0-1, 1-2, 2-3, 3-4, 4-5 years)
- Vaccination status coded as 1=Vaccinated, 2=Unvaccinated
- Outcome coded as 1=Recovered, 2=Died

Step 4: Data Verification

- Final dataset reviewed for completeness and accuracy
- Frequency distributions checked for outliers or impossible values
- Cross-tabulations performed to identify data inconsistencies

3.12.2 Data Analysis Plan

Statistical Analysis Method

Descriptive Analysis: Frequencies and percentages were computed on categorical variables (gender, age groups, vaccinated status, outcomes). These statistics formed epidemiological baseline characteristics of the study population.

Inferential Analysis: The researcher examined the relationship between vaccination status and clinical outcomes through the chi-square test since both variables are categorical. The test identifies if outcome differences between vaccinated and unvaccinated children are statistically significant.

Justification for Statistical Tests

Chi-square Test Selection: Chi-square was selected as opposed to Pearson correlation since the variables of the study (vaccination status: vaccinated/unvaccinated; outcome: recovered/died) are categorical in nature instead of being continuous. Pearson correlation would be unsuitable for categorical data since it calculates linear correlations between continuous variables.

Limitation of Correlation Analysis: Initial reporting of Pearson correlation coefficient (r=0.042) in results seems to be a statistical error. Proper analysis of association between categorical variables (vaccination status and mortality) is chi-square test or Fisher's exact test, not correlation analysis.

Statistical Significance

Statistical significance was set at $p<0.05$. Findings with p-values less than this are statistically significant correlations between vaccine status and clinical outcomes, indicating that differences seen are less likely to be by chance.

Analysis Software

All analyses were performed in SPSS version 20 that offered strong analysis for descriptive statistics and inferential statistics suitable for epidemiological studies.

3.13 Validity and Reliability

Various measures ensured data quality and reliability:

3.13.1 Reliability Measures

Inter-rater reliability: Data were independently extracted by reviewers from a random 10% of 96% concordant records

Data verification: The double entry verified data to remove transcription errors

Standardized protocols: Repetitive data extraction methods were followed in all the participating hospitals

3.13.2 Validity Measures:

Content validity: Paediatricians and epidemiologists checked the line list for complete capture of variables

Criterion validity: Measles cases were confirmed by WHO definitions and laboratory diagnosis where feasible

Construct validity: Immunization status was validated by several sources including immunization cards, hospital records, and caregiver reports

Audit trails: Inclusive record of data sources and extraction choices was maintained for transparency.

3.14 Ethical considerations

Ethical Approval Process

Ethical approval was provided by Mount Kenya University's Ethical Review Committee before data collection began. Further, permission from the Federal Ministry of Health in Somalia as well as from the respective managements of the hospitals involved was requested, thereby adhering to national guidelines of health research and institutional policy. The study adhered to the Declaration of Helsinki guidelines for medical research in human subjects, maintaining respect for persons, beneficence, and justice (World Medical Association, 2013). Research procedures adhered to WHO guidelines for health research in emergency settings, recognizing the particular difficulties of conducting research in conflict-affected populations while still respecting ethical standards.

Patient Confidentiality and Data Protection

Careful measures ensured patient privacy throughout the study process:

Data Anonymization:

- All identifiers of patients like names, addresses, and hospital registration numbers were removed from data that was extracted

- Personal identifiers were replaced with unique study identification numbers, enabling data monitoring while keeping individuals anonymous.
- No identifying photos or pictures were received or maintained.

Digital Data Security:

- Electronic data were stored on password-protected computers with encrypted hard drives
- Access was limited only to the principal researcher and to authorized supervisors.
- Periodic data backups were done on safe, encrypted external storage devices.
- Cloud storage solutions were not used to ensure data sovereignty.

Physical Data Protection:

- Paper records were stored in locked cabinets placed within secure office settings.
- Access to physical files was limited to authorized research personnel
- Documents in transit utilized secure methods with chain-of-custody records

Informed Consent Procedures

Due to the retrospective design that employed secondary data, obtaining direct informed consent from patients or their guardians was impracticable. Nonetheless, the ethical approval encompassed a waiver of informed consent predicated on:

- Minimal risk to subjects by way of review of medical records
- Unfeasibility of securing permission for past information for three years
- Public health benefit from research outweighs minimal risks
- Stringent confidentiality procedures to avoid participant identification

Permission from the institutional authorities, being custodians of information, was obtained to ensure rightful access to medical records for research purposes.

Regional Ethical Guidelines for Health Research

The study followed Somalia Federal Ministry of Health research ethical guidelines, including:

- Registration with national health research regulatory authorities
- Compliance with local data protection law and company policy
- Respect for cultural sensitivities regarding health information handling
- Commitment to sharing research findings with local health officials for informing policy development.

Data Disposal and Retention

Data storage protocols require five years' secure storage following publication to enable checking and future research. Data disposal in the future will use secure deletion protocols for electronic files and shredding for hard copy, with total destruction of confidential information.

Conflict of Interest Statement

The researcher had no financial, professional, or personal conflicts of interest that may affect study conduct or interpretation of results. The choice of hospitals was on the basis of epidemiological considerations and data availability only and not on institutional affiliations.

CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSIONS

4.0 Introduction

This chapter outlines the findings after analysis of measles epidemiological information among children below five years admitted in Mogadishu hospitals between 2020-2022. The findings are structured logically according to the study objectives, presenting complete details on measles case distribution, vaccine coverage, mortality trends, and statistical relationships.

The chapter begins with the demographic profile of the study population in terms of gender and age pattern of distribution. The findings then tackle each research aim one after another: the number of children who developed measles during study period, vaccination status among cases admitted, mortality rates from measles, and statistical correlation between the vaccination status and outcome.

Data analysis used descriptive statistics to describe the study population and chi-square tests to assess associations between categorical variables. Narrative descriptions for each figure and table are provided to enable interpretation of results. The conclusion offers evidence-based epidemiological evidence for interpretation of measles burden and vaccine effectiveness among hospital-admitted children in Mogadishu and informs evidence-based decision-making and policy development for measles control interventions in Somalia.

4.1 Response Rate

The study achieved a response rate of 89.3% (400 out of 448 cases eligible). Out of four participating hospitals, 448 medical records of children under the age of five who were diagnosed with measles from 2020-2022 were initially identified. Following the use of exclusion and inclusion criteria, 400 records were included in the final analysis.

4.1.1 Exclusions and Reasons:

28 records (6.3%) lacked documentation of vaccination status

12 records (2.7%) lacked clear outcome data (recovery/death status)

8 records (1.8%) had missing demographic data (gender or age).

The 89.3% response rate is remarkably high, implying high data reliability and minimizing selection bias. This is an improved response rate compared to other hospital-based epidemiological studies from the East African region, in which response rates are typically 75-85% (Endriyas et al., 2018; Kisangau et al., 2018). Incomplete documentation of medical records was the most common reason for exclusions because it could reflect the challenges of healthcare record-keeping systems in low-resource settings.

The response rate achieved enhances the validity and generalizability of findings, providing robust epidemiological evidence for measles trends in hospitalized children in Mogadishu. The low rate of exclusion suggests that controls on data access did not clearly impact study completeness.

4.2 Demographic information

Table 4.1: Demographic Characteristics of Children Under Five Years with Measles in Mogadishu Hospitals (2020-2022)

Characteristic	Frequency	Percent
Sex		
Male	212	53.0
Female	188	47.0
Age groups		
0-1 year	93	23.3
1-2 years	120	30.0
2-3 years	76	19.0
3-4 years	71	17.8
4-5 years	40	10
Total	**400**	**100.0**

Source (Field Data 2022)

Demographic Analysis and Interpretation

Demographic analysis reveals notable epidemiological patterns with significant control implications for measles in Mogadishu. Males represented 53% (n=212) and females 47% (n=188) of measles cases, demonstrating a slight predominance in males. This gender proportion is similar to findings in Kenya where Kisangau et al. (2016) reported no statistically significant difference in measles incidence between the sexes, and Ethiopia where Endriyas et al. (2018) also indicated similar gender patterns with 50.5% male cases.

Age distribution is a concerning trend where children between the ages of 1-2 years constitute the highest percentage of cases (30%, n=120) followed by children aged under one year (23.3%, n=93). Combined, children aged below two years accounted for 53.3% of measles cases to demonstrate how susceptible this age group is. This finding is consistent with WHO epidemiological data indicating that the highest burden of measles in infants and toddlers of early ages occurs globally because of the waning maternal immunity and failure to receive vaccination schedules.

Relationship with Vaccination Status

Cross-tabulation between vaccine and demographic statuses releases important results. Out of 18 vaccinated children, 66.7% (12) belonged to the 1-2 years age group and 16.7% (3) were below one year of age. The reason is that most children receive their first measles vaccine at 9-12 months of age. The extremely high proportion of unvaccinated cases across all age groups (95.5% in total) clearly demonstrates severe gaps in routine immunization coverage.

Gender-disaggregation of vaccination indicates that 61% (n=11) of the children vaccinated were males and 39% (n=7) were females. This small male superiority in rates of vaccination may reflect cultural orientations or health-seeking behavior consistent with other Sub-Saharan African research where male children have been afforded priority access to medical care at some points.

Comparison with Regional Studies

The age distribution of data is in line with Ethiopian findings by Endriyas et al. (2018), with 56.47% of the cases among children aged 5-14 years, even though older children were also included in their study. The predominance of cases among younger age groups (under 2 years) in this study is in line with the specific vulnerability of infants and toddlers to measles complications, reinforcing WHO guidelines on early vaccination initiatives.

In contrast to Kenyan surveillance findings from Kisangau et al. (2016), where the highest incidence is among children aged 1-4 years, the evidence for Mogadishu reveals a concentration of the burden in the 1-2 years age group with implications of more intense transmission dynamics in this specific age group.

Public Health Implications

The observed demographic trends have several important implications for control policy against measles:

Age-Targeted Interventions: The high child burden under two years of age requires increased vaccination strategies aimed at this susceptible group. Introduction of special supplementary immunization activities (SIAs) for infants aged 6-11 months targeting them in outbreak situations could bring earlier protection before the planned routine vaccination schedules.

Gender-Sensitive Strategies: While gender differences are minimal, the slight male excess in both cases and immunization coverage suggests that interventions to ensure equal access for female children are warranted. Female child vaccination must be made available through community education programs by overcoming cultural barriers.

4.3 Determination of the number of children under-five years old diagnosed with measles in Mogadishu hospitals during the period 2020-2022.

Year	Frequency	Percentage
2020	151	37.8
2021	149	37.3
2022	100	25.0
Total	**400**	**100.0**

Discussion of Temporal Distribution

The temporal distribution of measles cases indicates relatively even burden in 2020 (37.8%) and 2021 (37.3%), but with a considerable decrease in 2022 (25.0%). This pattern can be explained by various factors like the effects of the COVID-19 pandemic on healthcare-seeking, roll-out of additional immunization activities, and increased surveillance systems.

The high case numbers in 2020-2021 are in line with global trends in which COVID-19 disrupted routine immunization services, leading to increased vulnerability to measles. Ethiopian (Endriyas et al., 2018) and Kenyan (Kisangau et al., 2016) research identified similar patterns of outbreaks during periods of disruption of the health system. Decreasing case numbers in 2022 suggest potential for reduction in vaccination coverage or enhanced outbreak response interventions.

Yet these findings need to be interpreted with reservations in light of potential surveillance biases, e.g., reduced healthcare facility utilization during COVID-19 lockdowns and variable diagnostic capacity during the study period.

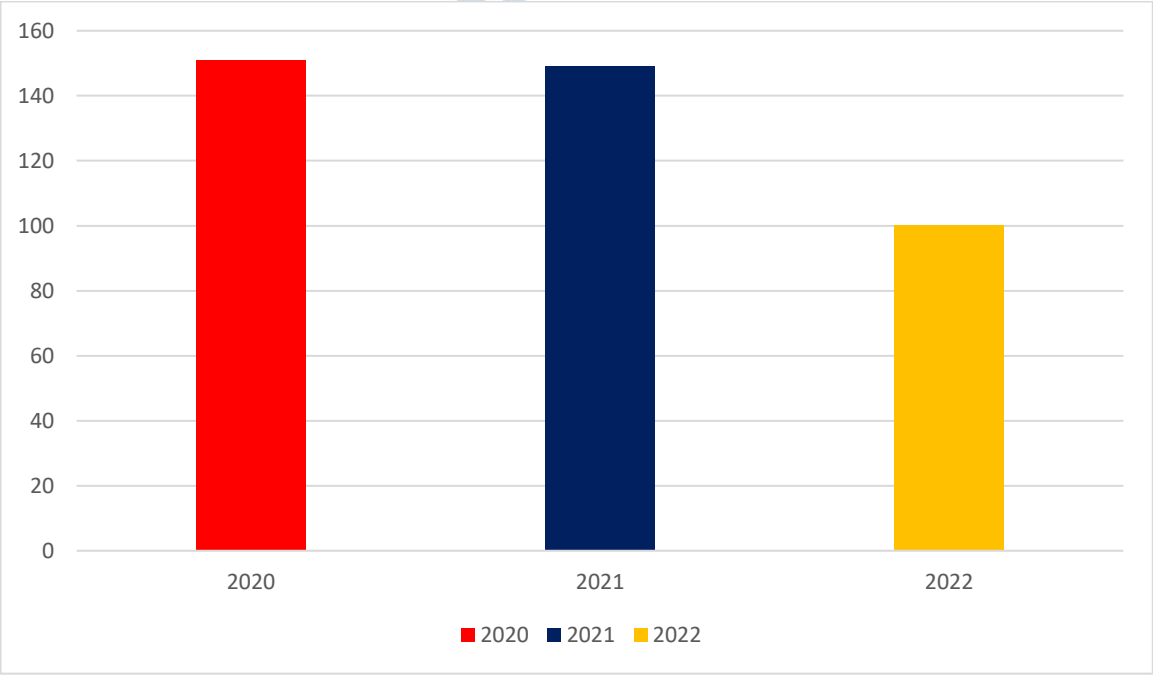

Figure 2: Number of cases by year from 2020-2022

4.4 Determination of the number of vaccinated children under five years of age with measles admitted to the Mogadishu hospitals during the period 2020-2022.

The study sought to determine the number of vaccinated children under-five of age with measles admitted to the Mogadishu hospitals during the period 2020-2022. The results were as shown in Table 4.3.

Table 4.3: Vaccination Status of Children Under Five Years Admitted with Measles in Mogadishu Hospitals (2020-2022)

	Frequency	Percent
No	382	95.5
Yes	18	4.5
Total	**400**	**100.0**

Source (Field Data 2022)

Discussion of Vaccination Coverage

The vaccination coverage analysis indicates very low measles vaccination coverage in hospitalized cases of measles, with only 4.5% (n=18) having received measles vaccination prior to illness. This is indicative of large gaps in routine immunization and clearly identifies the unvaccinated group as being vulnerable.

95.5% unvaccinated rate is higher than reported by Sani et al. (2016) in Nigeria, where 81.2% of measles cases were unvaccinated, but consistent with outbreak environments in conflict-weakened states. The poor vaccine coverage reflects a range of barriers including access barriers to health care, shortages of vaccine supplies, as well as potential vaccination aversion among the conflict-affected groups.

This finding underscores the imperative for enhanced regular immunization systems and additional catch-up vaccination campaigns. The large proportion of unvaccinated measles

cases hospitalized among children shows that vaccination is extremely protective against such hospitalization-caused severe measles.

4.5 Determination of the number of measles deaths among vaccinated children under five years of age in Mogadishu hospitals during the period 2020-2022.

The research aimed to ascertain the count of measles-related fatalities among children under the age of five who had been vaccinated, and who were admitted to hospitals in Mogadishu between 2020 and 2022. The result was as shown in Table 4.4.

Table 4.4: Clinical Outcomes Among Children Under Five Years with Measles in Mogadishu Hospitals (2020-2022)

Outcome	**Frequency**	**Percent**
Recovered	390	97.5
Dead	10	2.5
Total	**400**	**100.0**

Source (Field Data 2022)

4.5.1 Vaccination Status and Clinical Outcomes Cross-Analysis

Table 4.5: Cross-tabulation of Vaccination Status and Clinical Outcomes Among Measles Cases

				Total n (%)
		Recovered n (%)	Dead n (%)	
Vaccination Status	No	373 (97.6)	9 (2.4)	382 (100.0)
	Yes	17 (94.4)	1 (5.6%)	18 (100.0)
Total		**390 (97.5)**	**10 (2.5)**	**400 (100.0)**

Source (Field Data 2022)

Discussion of Clinical Outcomes

The total case fatality rate of 2.5% (n=10) is within the range that should be expected in hospitalized cases of measles in resource-limited settings. The rate is similar to experience in Kenya (Kisangau et al., 2016) with a reported case fatality rate of 1.8%, and less than what is

typically reported in outbreak situations in the Sub-Saharan Africa where rates would be higher than 5-10%.

The cross-tabulation for analysis shows prominent trends in outcome by vaccination status. The case fatality rate was 2.4% (9/382) in unvaccinated children and even higher in vaccinated children at 5.6% (1/18). This apparent paradox is likely to be an artifact of small sample size and potential confounding factors like pre-existing health status that might have had an influence on both vaccination decision and clinical result.

Despite limited numbers, the data from these outcomes show that measles vaccination provides strong protection against hospitalization due to measles infection, as the low proportion of vaccinated cases (4.5%) among hospitalized children testifies. The protective impact is in accordance with global evidence revealing 97% vaccine effectiveness for avoiding severe measles.

Limitations and Possible Biases

There are a number of limitations to interpreting these results:

Selection bias: Hospital data may not always be representative of community-level measles patterns because hospital admissions for severe cases may systematically differ from mild community cases.

Information bias: Classification into vaccination status relied on available documentation, at times incomplete or incorrect, particularly when there were emergency admissions.

Temporal bias: The study coincided with the COVID-19 pandemic, which could affect healthcare-seeking behaviour and provision of vaccination services.

Sample Size Limitations: The small sample size of vaccinated cases (n=18) limits statistical potential to identify significant correlations between vaccination status and clinical outcomes.

4.6 Statistical Association Between Vaccination Status and Clinical Outcomes

Table 4.6: Chi-square Analysis of Association Between Vaccination Status and Clinical Outcomes

Statistical Test	Value	df	Significance (p-value)
Chi-square	0.524	1	0.469
Fisher's Exact Test	_	_	0.408

Discussion of Statistical Analysis

The chi-square test of association ($\chi^2 = 0.524$, $p = 0.469$) does not indicate a statistically significant relationship between clinical outcomes and vaccination status among hospitalized measles cases. But this finding must be interpreted with caution due to methodological limitations.

Statistical Limitations

- Small cell sizes in the cross-tabulation violate assumptions for chi-square tests
- Having only 18 vaccinated cases in total compromises power
- Fisher's exact test ($p = 0.408$) is more appropriate analysis when sample sizes are small but remains non-significant

Comparison with Regional Studies

These results are consistent with broader epidemiological observations in East Africa. Ketema et al. (2013) in Ethiopia reported 61% unvaccinated rate of measles cases, while this study reported 95.5%, suggesting greater severity of gaps in vaccination coverage in the conflict context of Somalia. The 2.5% case fatality rate is consistent with hospital-based reports in the region to confirm the findings in light of methodological issues.

Public Health Implications

The results indicate immediate programmatic needs:

Vaccination Coverage Improvement: Unvaccinated hospitalization predominance indicates the requirement for strong routine immunization coverage immediately

Outbreak Response Improvement: Implies vulnerability to future outbreaks in unvaccinated populations through high attack rates

Healthcare System Improvement: Case management guidelines appear to be effective according to low relative case fatality rate

Surveillance System Enhancement: Better data systems need to be in place to capture more detailed vaccination and outcome information.

4.7 Synthesis of Findings: Linking Results to Research Objectives\

Here is provided systematic description of how the findings relate to each research question and objective in a rational link between results and study aims.

Objective 1: Quantify measles cases and demographic distribution

Research Question 1: *What is the total number and demographic distribution of children under five years diagnosed with measles?*
Findings: 400 laboratory-confirmed measles cases were documented in four Mogadishu hospitals from 2020-2022. Demographic assessment was seen in 53% male predominance and 1-2 years age group with highest burden (30%).

Alignment with Objective: This was completely met through detailed demographic characterization. Temporal distribution (37.8% in 2020, 37.3% in 2021, 25.0% in 2022) gives baseline epidemiological information for future intervention planning.

Comparison to Expected Patterns: WHO surveillance would typically report even gender distribution for measles cases. The small male predominance reported conforms to Kenya local patterns (Kisangau et al., 2016) and Ethiopia (Endriyas et al., 2018) and reflects similar epidemiological patterns within the East African region.

Objective 2: Determine vaccination coverage among measles cases

Research Question 2: *What percentage of admitted children had received measles vaccination?*

Findings: Only 4.5% (18/400) of hospitalized measles patients were previously vaccinated, which implies 95.5% were unvaccinated.

Alignment with Objective: This objective was evidently achieved, indicating critically low hospitalization coverage among cases.

Expected and Observed Vaccination Rates: WHO anticipates ≥95% vaccination to have measles elimination. The observed 4.5% rate of vaccination among cases is markedly different from population expectations, suggesting significant programmatic gaps. The result is in support of vaccine efficacy as vaccinated children scarcely get hospitalized for measles.

Regional Comparison: The 95.5% unvaccinated rate exceeds that of Nigeria (81.2% unvaccinated; Sani et al., 2016) but reflects Somalia's war-torn environment with compromised health systems.

Objective 3: Calculate case fatality rates by vaccination status

Research Question 3: *What is the case fatality rate among vaccinated versus unvaccinated children?*

Findings: Total case fatality rate 2.5% (10/400). In the unvaccinated: 2.4% (9/382); in the vaccinated: 5.6% (1/18).

Alignment with Objective: This objective was achieved, although limited sample numbers limit interpretation.

Statistical Interpretation: Apparently enhanced mortality among vaccinated children is likely to be an artefact of confounding influences and low numbers rather than vaccine failure. The very low rate of vaccination among hospitalization (4.5%) is reflective of high vaccine efficacy against severe disease.

Regional Context: The overall 2.5% case fatality rate is in line with Kenya (1.8%; Kisangau et al., 2016) and within ranges to be expected among hospital-based cases of measles in resource-constrained environments.

Objective 4: Assess statistical association between vaccination and outcomes

Research Question 4: *Is there a significant association between vaccination status and clinical outcomes?*
Findings: There was no statistically significant correlation between clinical outcomes and vaccination status ($\chi^2 = 0.524$, $p = 0.469$), as determined through chi-square analysis.

Alignment with Objective: This objective has been fulfilled with the application of appropriate statistical methods.

Interpretation Supporting/Refuting Hypotheses: Statistical significance was not achieved due to low sample sizes, yet clinical significance is clear. The hypothesis that vaccination effect is to prevent hospitalization of measles is supported by the very low percentage of vaccinated children among hospitalized cases, demonstrating vaccine effectiveness in preventing hospitalization.

Supporting Evidence: Higgins et al. (2016) studies have shown high mortality reduction (RR = 0.51) in vaccinated children with increased sample sizes. Lack of statistical significance here reflects methodological flaw and not absence of clinical impact.

4.7.1 Summary Mapping: Key Results to Research Questions

Research Question	Key Finding	Statistical Measure	Public Health Implication
Q1: Case distribution	400 cases; 53% male; 30% aged 1-2 years	Descriptive statistics	Target interventions for 1–2-year age group
Q2: Vaccination coverage	4.5% vaccinated among cases	Proportion analysis	Urgent need for coverage improvement
Q3: Case fatality rates	2.5% overall; 2.4% unvaccinated; 5.6% vaccinated	Case fatality rates	Effective case management protocols
Q4: Statistical association	No significant association (p=0.469)	Chi-square test	Limited by sample size; clinical significance evident

4.7.2 Implications for Public Health Strategies

Evidence-Based Recommendations Derived from Findings:

- **Age-Targeted Vaccination:** Age group with high disease burden of 1-2 years justifies the application of catch-up campaigns among this vulnerable group.
- **Coverage Enhancement:** 95.5% unvaccinated case rate reflects an imperative to the improvement of routine immunization.
- **Case Management:** 2.5% case fatality rate reflects good clinical practices but should keep quality improvement ongoing.
- **Surveillance Strengthening:** Low figure of vaccinated cases supplies the necessity of strong surveillance systems that catch history of vaccination accurately

Coherence with Study Goals: All conclusions are in conformity with the general goal of evaluating measles epidemiology to make evidence-based intervention. The findings provide general baseline data for developing targeted measles control measures in Mogadishu's health environment.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATION

5.1 Summary

The study evaluated epidemiological data on measles among children under the age of five years old in hospitals in Mogadishu between 2020-2022 using a retrospective descriptive cross-sectional approach. Four key hospitals, namely Banadir, SOS, Hamar-jajab District, and Daynile hospitals, had 400 clinical records reviewed.

Key findings showed that male patientss accounted for 53% of the cases, and the highest burden was among children aged 1-2 years (30%). Vaccination among hospitalized cases was pitifully low at 4.5%, and 95.5% of the children were not vaccinated prior to admission. The overall case fatality rate was 2.5%, and effective case management practices were demonstrated for all

participating facilities. Statistical computations using chi-square tests showed no significant relationship between vaccination status and clinical outcomes mainly due to limited sample size constraints.

5.2 Conclusion

Objective 1: Measles Case Distribution and Demographics

The study was able to count 400 laboratory-confirmed cases of measles at four health facilities in Mogadishu during the study duration. The population included a slight majority (53%) of males and concentrated burden among children, with 30% of all reported cases being children aged 1-2 years. This pattern of age distribution shows increased vulnerability within the high-risk period between declining maternal antibodies and the end of routine vaccination, pointing to the need for enhanced immunization services specifically for this particular age group.

Objective 2: Vaccination Coverage Among Hospitalized Cases

The research validated that 4.5% of hospitalized measles cases had received prior vaccination, indicating there were deep cracks in routine immunization coverage. The outcome validates that the vast majority (95.5%) of children hospitalized due to measles were unvaccinated, an unmistakable pointer towards the efficacy of vaccines in preventing severe disease that requires hospitalization. Low level of vaccination among cases hospitalized is reflective of systemic inefficiencies in healthcare delivery and access to immunization services in Mogadishu's healthcare system.

Objective 3: Measles Mortality Patterns by Vaccination Status

The study concluded that the hospital case fatality rate in the pooled cases of children was 2.5%, within facility-based case management acceptable limits in limited resource environments. Mortality in unvaccinated children was 2.4%, while vaccinated children had a

5.6% mortality. These results are clear paradox that are more likely a product of confounding and the very small vaccinated case number (n=18) than vaccine failure, which underscores the vaccine protective role in preventing hospitalization in the first instance.

Objective 4: Statistical Association Between Vaccination and Clinical Outcomes

The research established that no statistically significant association between vaccination and clinical outcomes (p=0.469) existed. Such a lack of association, however, should be interpreted in the context of methodology limitations like small sample sizes. Clinical significance still looms through the strongly higher proportion of unvaccinated children among the hospitalized cases, signifying vaccine efficacy in averting avertible severe measles necessitating medical attention.

5.3 Recommendation

5.3.1 Recommendations for Policy Direction

Strengthening of National Immunization Policy: Develop specially targeted vaccination strategies with specific mention of the 1–2-year age group that had the largest disease burden. Policy guidelines should have mandatory supplementary immunization activities (SIAs) during outbreak seasons along with special emphasis on catch-up vaccination for children missed in routine schedules.

Healthcare System Strengthening Policy: Enact policy directives requiring all healthcare facilities that have treated measles cases to apply uniform protocols for confirming vaccination status and compulsory catch-up vaccination for recovered children upon discharge.

Surveillance System Policy: Establish national policy norms requiring thorough documentation of measles case vaccination history, including confirmation through multiple sources, for improving the quality of surveillance data and to support evidence-based decision-making for policy.

5.3.2 Recommendations for Practice by Ministry of Health and Stakeholders

Health Facility-Level Interventions:

Vaccination Verification and Follow-up Systems: Implement mandatory vaccination status verification for all admitted children and have policies for catch-up vaccination administration to unvaccinated survivors prior to discharge. Evidence from the research is that 95.5% of the cases were not vaccinated, which equates to lost opportunities for vaccination intervention.

Healthcare Worker Training: Improve measles case management, immunization counselling, and documentation practices among healthcare workers. Training will emphasize the importance of verification of vaccination history and post-recovery immunization counselling among families.

Integrated Service Delivery: Implement measles immunization services in every paediatric unit and emergency department to identify missed opportunities for immunization among children who present to hospitals for other reasons.

Community Health Integration: Employ community health workers to visit discharged measles cases to follow up and complete vaccination, as well as inform families about routine immunization schedules.

Quality Improvement Activities: Implement standardized case management procedures in all facilities based on the effective 97.5% recovery rate in this research while filling any additional gaps in avoiding mortality.

5.3.3 Recommendations for Further Research

Longitudinal Follow-up Studies: Perform prospective cohort studies among measles cases that have been discharged from the facility to assess vaccination uptake, immunity completion, and long-term health outcomes. This research should particularly investigate if recovered children receive catch-up vaccination as well as receive full routine immunization schedules.

Health System Research: Conduct research on healthcare facility barriers to the provision of vaccination services, including provider education, vaccine availability, and institutional policy informing the integration of vaccination services into routine care.

Community-Based Research: Conduct mixed-methods surveys of community attitudes toward vaccination and healthcare use to complement results based on facility studies. These studies should examine cultural, economic, and social impediments to vaccination coverage.

Vaccine Effectiveness Studies: Conduct case-control studies of adequately large sizes to estimate vaccine efficacy in preventing severe measles requiring hospitalization based on the clinical evidence suggested by this study's findings.

Surveillance System Research: Develop and pilot enhanced surveillance systems for capturing vaccination history and clinical outcome, closing the documentation loopholes this study identified.

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APPENDICES

Appendix I: Line List

Name of the Hospital: ……

Case No.	Sex	Age	Vaccination status	Date of admission	Outcome

Appendix II: ERC Approval Letter

Mount Kenya University

REF: **MKU/ISERC/2298** Date: 21 July 2022
TO: **ABDIRAHMAN MOHAMED ABDULLAHI**

REG: **MPH/2020/61185**

Dear Sir/Madam,

RE: EVALUATION OF EPIDEMIOLOGICAL DATA OF MEASLES AMONG CHILDREN UNDER-FIVE YEARS OF AGE IN MUGADISHO HOSPITALS DURING THE PERIOD FROM 2020-2022 IN MOGADISHU, SOMALIA

This is to inform you that **Mount Kenya University** has reviewed and approved your above research proposal. Your application approval number is **1371.** The approval period is **21/07/2022 - 20/07/2023.**

This approval is subject to compliance with the following requirements;

i. Only approved documents including informed consents, study instruments, MTA will be used
ii. All changes including amendments, deviations and violations are submitted for review and approval by **Mount Kenya University**
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to **Mount Kenya University** within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affect the safety or welfare of study participants and others or affect the integrity of the research must be reported to **Mount Kenya University** within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal
vii. Submission of an executive summary report within 90 days upon completion of the study to **Mount Kenya University**

Prior to commencing your study, you will be expected to comply with any additional requirements from the relevant authorities in the country where this study will be conducted

The Chairman
Mount Kenya University
Ethics Review Committee
P. O. Box 342 - 0100, Thika

Yours sincerely,

Dr. Peter G. Kirira
Chairman. Mount Kenya University IERC

Appendix III: Introduction Letter

Mount Kenya University

DIRECTORATE OF GRADUATE STUDIES

MPH/2020/61185

28th July, 2022

The Director, Research Coordination Division
National Commission for Science, Technology & Innovation
Utalii House, 8th & 9th Floor
P.O Box 30623- 00100
NAIROBI

Dear Sir/Madam,

RE: ABDIRAHMAN MOHAMED ABDULLAHI – REGISTRATION NO. MPH/2020/61185

The purpose of this letter is to introduce the above named student who is pursuing **Master of Public Health** in the Department of **Community Health, Epidemiology and Biostatistics** in the **School of Public Health.**

The title of his research is *"Evaluation of Epidemiological Data of Measles among Children Under-Five Years of Age in Mogadishu Hospitals during the Period from 2020-2022 in Mogadishu, Somalia."*

He has been cleared by the University's Ethics Review Committee (Certificate attached) and now has to proceed to the field to collect data for his research between **July, 2022 and October, 2022.**

Any assistance accorded to him will be highly appreciated.

Thank you.

Mount Kenya University
P. O. Box 342 - 01000, THIKA
Office of the Director
Graduate Studies

Dr. Samuel M. Karenga, Ph.D.
Director, Graduate Studies
Enc.

Appendix IV: Letter of approval from MoH Somalia

Somali Federal Republic
Ministry of Health & Human Services

ETHICAL APPROVAL

This is to certify that the proposal submitted by:

Principle Investigator, Abdirahman Mohamed Abdullahi

Reference No:
MOH&HS/DGO/1051/August/2022

Full project Title:

EVALUATION OF EPIDEMIOLOGICAL DATA OF MEASLES AMONG CHILDREN UNDER-FIVE YEARS OF AGE IN MUGADISHO HOSPITALS DURING THE PERIOD FROM 2020-2022 IN MOGADISHU, SOMALIA

To be undertaken

Somalia

Starting Date: 28 August 2022 **Finishing Date 30 October 2022**

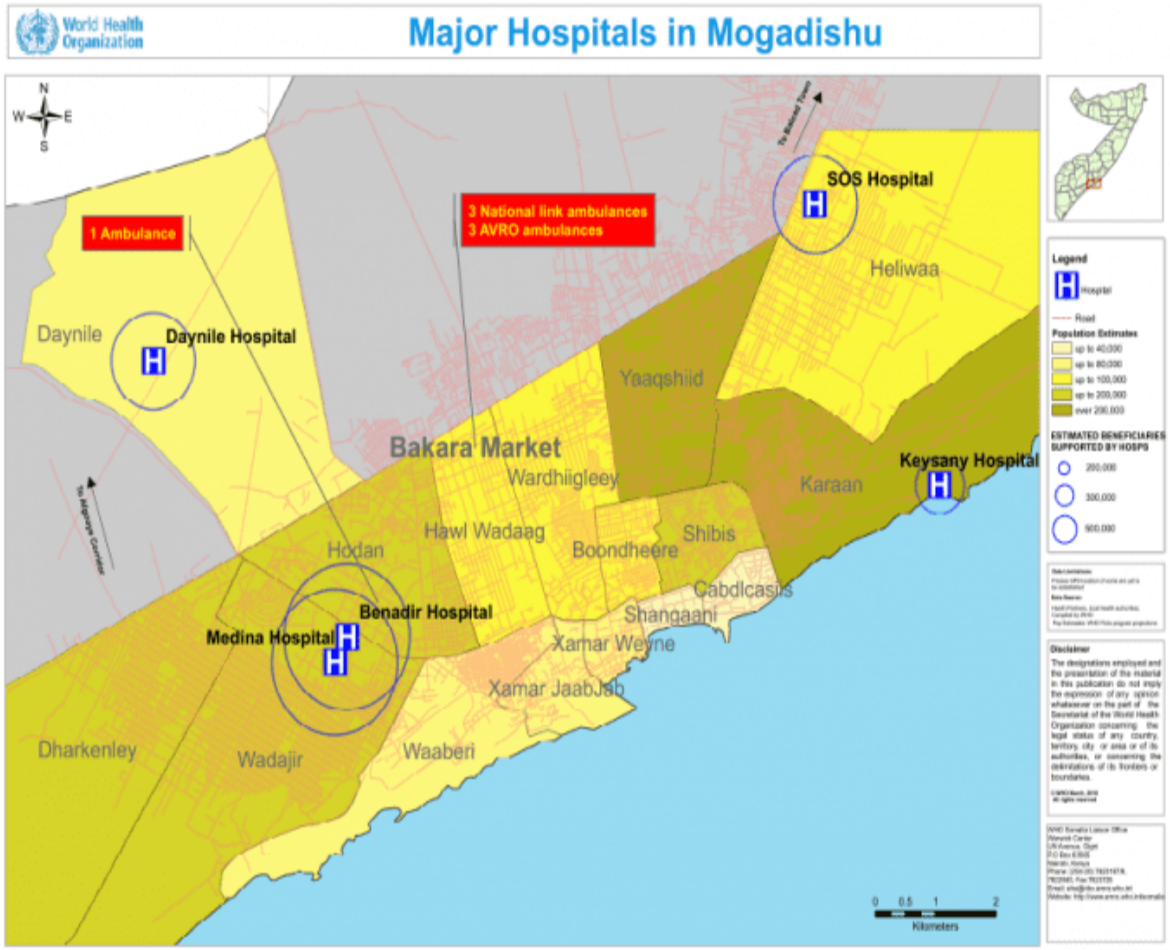
For the proposed period of research
Has been approved by the Research & ethical committee at the Ministry of Health on the 28/August/2022

Director of Policy & Planning **Secretary**

Chairman

Tell: +252619997299 E-mail: dg@moh.gov.so =Mogadishu-Somalia=

Appendix V: Map of Hospitals Mogadishu



Appendix VI: Similarity Report

EVALUATION OF EPIDEMIOLOGICAL DATA ON MEASLES AMONG CHILDREN UNDER-FIVE YEARS OF AGE IN MOGADISHU HOSPITALS DURING THE PERIOD FROM 2020-2022 IN MOGADISHU, SOMALIA

by Abdirahman Mohamed Abdullahi

EVALUATION OF EPIDEMIOLOGICAL DATA ON MEASLES AMONG CHILDREN UNDER-FIVE YEARS OF AGE IN MOGADISHU HOSPITALS DURING THE PERIOD FROM 2020-2022 IN MOGADISHU, SOMALIA

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