

Analyzing factors associated with immunization uptake in Puntland State, Somalia - A literature review.

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Declaration

Analyzing factors associated with immunization uptake in Puntland State, Somalia

A thesis submitted in partial fulfilment of the requirement for the Master of Science in Public Health.

By

Jamal Mohamed Warsame

Somalia

Declaration:

Where other people's work has been used (either from a printed source, the internet or any other source) this has been carefully acknowledged and referenced in accordance with departmental requirements. The thesis analyzing factors associated with immunization uptake in Puntland State, Somalia, is my own work.

Singature



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Finally, I am grateful to God for this opportunity and the gift of good health and happy life.

List of abbreviations

AEFI	Adverse Events Following Immunization
ANC	Antenatal Care
BCG	Bacillus Calmette-Guerin
DPT:	Diphtheria, Pertussis and Tetanus vaccine
EMRO	Eastern Mediterranean region office
EPHS	Essential Package of Health Services
EPI	Expanded Program on Immunization
GAVI	Global Alliance for Vaccines and Immunization GAVI
GDP	Gross Domestic Product
GVAP	Global Vaccine Action Plan
HDR	Human development report
Hib	Haemophilus Influenza type b
HMIS:	Health Management Information System
HR	Human resource
IDSR	Integrated Disease Surveillance and Response
IEC	Information Education and Communication
IFRA	International Federation of Red Cross and Red Crescent Societies
IMR:	Infant Mortality Rate
IPV	injectable Polio vaccine
LMICs	Low-and-Middle-Income Countries
MMR:	Maternal Mortality Ratio
MOH	Ministry of Health
NGO	Non-Government Organization
PHC	Primary Health Care
PNC	Postnatal care
RED	Reaching Every District

RI	Routine Immunization
SBA	Skilled birth attendance.
SCMYP	Somalia Comprehensive Multi-Year Plan
SDG:	Sustainable Development Goals
SHDS	Somali health Demographic survey
SIA	Supplemental Immunization Activity
TBAs:	Traditional Birth Attendants
U5MR:	Under Five Mortality Rate
UHC	Universal Health Coverage
UNFPA	United Nations Population Fund
UNICEF	United Nations Children’s Fund
VPDs:	Vaccine Preventable Diseases
WHO	World Health organization

Glossary

For the objective of this study, the terminologies utilized are based on WHO definition(1)

Vaccine: “A suspension of live (usually attenuated) or inactivated microorganisms (e.g. bacteria or viruses) or fractions thereof administered to induce immunity and prevent infectious diseases and their sequelae”.

Vaccine-preventable diseases (VPD): “infectious diseases caused by viruses or bacteria that can be prevented with vaccines”.

Vaccination: “The physical act of administering any vaccine or toxoid”

Immunization: “The process of being made immune or resistant to an infectious disease, typically by administering a vaccine. It implies that you have had an immune response”.

Cold chain: is a process that aims to ensure that vaccines are properly stored and transported at the appropriate temperatures for their intended use.

Expanded Programme on Immunization (EPI): “EPI is the program started by WHO in 1974 to support countries worldwide in their vaccination programs”.

Herd immunity: “A situation in which a sufficient proportion of a population is immune to an infectious disease (through vaccination and/or prior illness) to make its spread from person to person unlikely. Even individuals not vaccinated (such as newborns and those with chronic illnesses) are offered some protection because the disease has little opportunity to spread within the community.”

Access: “Is the ability of children to easily access immunization services to get all required doses as per the national policy”.

Coverage: “It is the percentage of children who obtain one or more vaccines in relation to the eligible population”.

Periodic Intensification of Routine Immunization (PIRI) “is a term that defines a continuum of time-limited, sporadic activities/campaigns employed to promote routine vaccinations to under-vaccinated inhabitants and/or raise awareness on the advantages of vaccination”.

Abstract

Background: Vaccine-preventable diseases (VPDs) are a significant public health concern in developing countries. Somalia has one of the lowest immunization coverage rates globally. Only 11% are fully immunized, while 60% have not received any vaccine. This study aimed to analyze the factors influencing immunization uptake and propose possible interventions to increase immunization coverage.

Methods: A literature review was performed using an analytical framework for studying determinants of vaccination by Acosta-Ramirez et al.

Findings: The study found maternal education, income, nomadic life, attitudes and perceptions of vaccines and VPDs are the most critical demand factors. The attitudes and perceptions are shaped partly by education, rural residence, ethnic group, and religious affiliation. Physical access to immunization services and a shortage of human resources have impacted the EPI's proper management. Further poor supply management, poor coordination with concerned stakeholders and lack of community strategies affecting people's expectations and trust are linked to demand factors that worsen the functioning of health systems. These factors are interlinked and influenced by external factors, such as conflict and disasters related to displacement

Conclusion:

The immunization coverage of Puntland state was extremely low in all regions. Underlying interlinked factors require a multisectoral and multidisciplinary response. Local and international stakeholders should support rebuilding the health system, especially primary care services and prioritising EPI. This should include sufficient, competent health workers. Further, to develop specific strategies like outreach and community-based initiatives to reach communities in slums, rural and nomadic areas.

Keywords: Vaccine Preventable Diseases, Immunization, Coverage, Access, Puntland state of Somalia Word Count: 13105 words

1. Chapter one: background.

1.1. Geography

Somalia is located in the horn of Africa, with a surface area of 637,657 km² and land primarily comprised of highlands, plateaus, and plains. Somalia has the longest coastline in Africa, 3,333 kilometres long, with the Indian Ocean to the south and east and the Gulf of Aden to the north. It shares its borders with the Republic of Djibouti (Northwest), the Federal Republic of Ethiopia (West) and Kenya (Southwest)(2). The temperatures in Somalia typically range from 30°C to 40°C throughout the year, with a hot tropical climate. There are only two rainy seasons, Gu' and Deyr, and two dry ones, Haga and Jill, in the country, which results in low annual rainfall. Floods and droughts have become more frequent across the country because of changing, unpredictable climate patterns over time(2).

1.2. Demography

The most recent nationwide population estimation exercise conducted by the statistical offices of the Ministry of Planning and the United Nations Population Fund (UNFPA) estimated the Somali population at 12.3 million. Around 23% of the Somali people live in rural, 26% live in nomadic regions, 9% live in IDP camps, and 42% live in urban(2). Women make up 49% of the total population, with 50% being of childbearing age (15-49 years). Children under the age of five accounted for 17 per cent of the population, while those aged five to nine accounted for 14 per cent of the population, and those aged 15 to 64 comprised 53 per cent of the population as per (Figure 1)(2). Somalia consists of two ethnic groups Somalia 85%, and Somali Bantu, 15%. 100% of Somali people are Sunni Muslims. Languages spoken in Somalia are Somalia, Arab, English, and Italian(3).

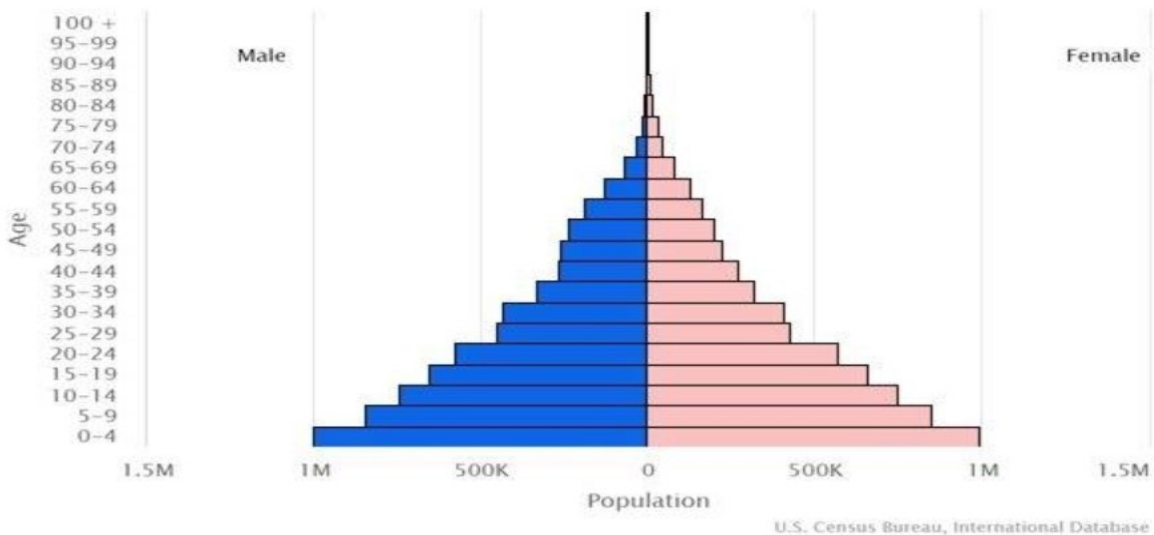


Figure 1: Somalia population pyramid 2014

1.3. Political and administrative structure

Somalia gained its freedom on July 1, 1960, from Italy and, soon after, joined with the British Protectorate Somaliland, which became independent from the British on June 26, 1960, to form Somalia government(4). In 2012 Somali government adopted the federal system. Federal institutions were established, and the basic administrative structure of federal governance was initiated(4). Since then, the Federal Member States (FMS) have emerged, Puntland and Somaliland, Jubbaland, Galmudug, Southwest, and Hir-shabelle(Figure 2)(4).

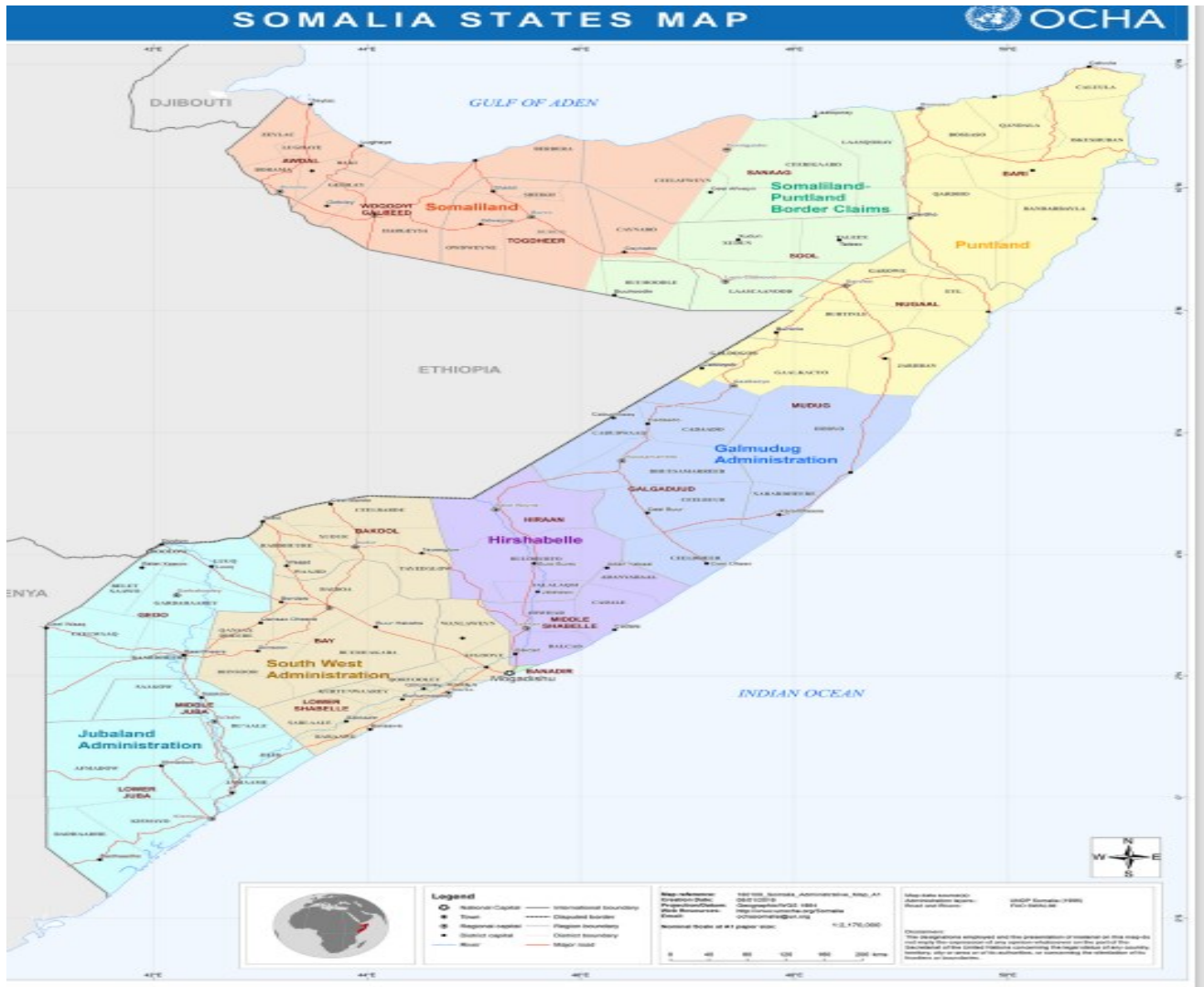


Figure 2: Geography of Somali federal states (4).

1.4. Economy

After more than three decades of political turmoil in Somalia, the country's economy has faced critical challenges to progress. In 2018, Somalia's Gross Domestic Product (GDP) was 4.7 million USD, and its per capita GDP was approximately USD 315(6). However, in the 2019 Human Development Report (HDR), Somalia ranks among the four least developed countries (5). The economy of Somalia mainly depends on livestock and agriculture, which account for 65% of the GDP. These two sectors also employ 65% of the total workforce in the country. Fish, charcoal, sugar, and bananas are other important products in the country(5).

1.5. Somalia's Health system and major challenges

The political context in Somalia: Somalia has experienced prolonged conflict and civil war, which impacted the health of the Somali population in different ways. The conflict is the primary driver of the displacement of the people(6). The war destroyed health facilities and affected the availability of health services to the population, which increased morbidity and mortality. The mass movement and overcrowding of people caused by conflict increased outbreaks of vaccine-preventable diseases such as measles, polio, and whooping cough. Further, poor sanitation and lack of clean water increased the risk of infectious diseases such as measles, cholera, TB, and malaria(6). There are challenges to obtaining a detailed and accurate record concerning changes in disease burden in the country due to insufficient or absent data management systems, forced migration, and poor reporting mechanisms(7). The recurrent severe droughts and COVID-19 have overwhelmed the population's health status and severely damaged its fragile health system(7). Political conflicts among member states and the federal government have affected the implementation of humanitarian responses and service delivery. The roles and responsibilities are not always well defined and lead to programmatic challenges to endorse specific national EPI strategies and documents and conduct country coordination meetings(7).

Health system in Somali

The life expectancy of Somali people is estimated at 58 years(8). Although Somalia had among the highest maternal, and child mortality ratios in 2020, there was a remarkable improvement in MMR from 1600 deaths per 100 000 pregnant women in 2005 to 692 deaths per 100,000 live births in 2020. The under-five mortality has improved from 200 deaths per 1000 live birth in 2010 and declined to 117 deaths per 1000 in 2020. The infant mortality rate (IMR) is 80 deaths per 1000 live births, improved from 91 deaths per 1000 in 2014. Diarrhea, malnutrition, measles, and pneumonia account for most deaths among children (8). The service utilization rate is low in Somalia; only 31% of pregnant women had access to a first Antenatal care visit with skilled health workers. Only 8% received four recommended ANC visits, while 21% were delivered at health facilities with professional midwives. According to the FSNAF estimates of the burden of acute malnutrition in Somalia for 2021, a total of 840 000 children under five are likely to be malnourished (of whom 55% were girls and 45% were boys), including nearly 143 000 who are likely to be severely malnourished(10).

An Essential Package of Health Services (EPHS), which was developed in 2012, serves as the framework for Somalia's health care delivery. In Puntland state, there are four service levels: primary health units (PHU), health centres (HC), referral healthcare facilities (RHC), and hospitals. Immunization is one of the six core programs, besides there are four additional programs (Figure 3) (9). The provision of service delivery faces many challenges, including poor regional and district leadership skills, weak institutional capacities, and a lack of supportive supervision. The Somali human resource for health (HRH) deficiency is substantial. The density of nurses, doctors, and midwives is 0.4 per 10,000 population, far below the global benchmark of WHO at 23 per 10,000(9).

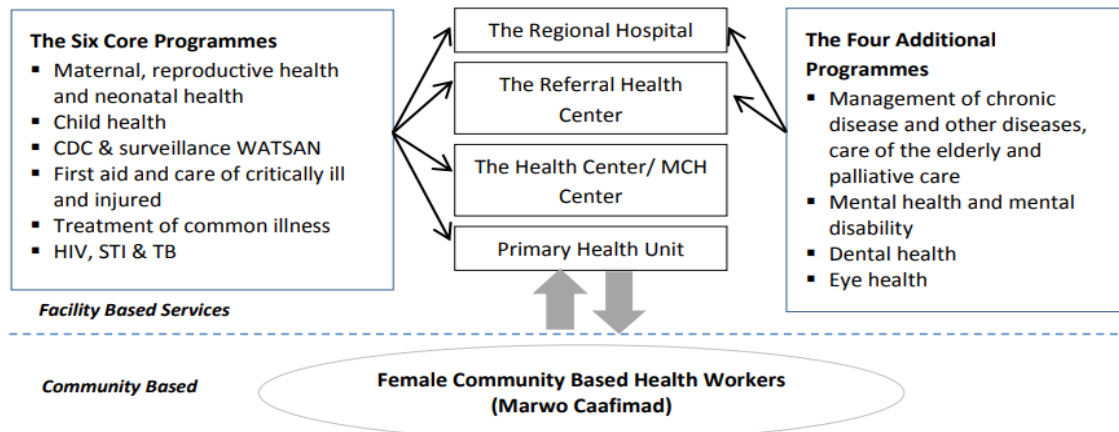


Figure 3: EPHS framework (ten program and health care levels (15)

1.6. Immunization system in Somalia

The expanded immunization program (EPI) was introduced in Somalia in 1978, with the support of multilateral organizations. However, EPI services were significantly affected by the prolonged conflict(8). The international community, led by UNICEF, began delivering immunization services in 1993. Since 2002, The Global Vaccine Alliance (GAVI), UNICEF and WHO have financially supported the EPI program. UNICEF is responsible for procuring and distributing the vaccine and cold chain maintenance. Also, social mobilization development and dissemination of Information Education and Communication (IEC) while WHO provides technical assistance to the ministry of health(8).

In 2020, the Somali government revised the Somali national immunization policy. The policy aimed to provide the overall strategic directions to the federal health authorities and its partners on the EPI program to strengthen the immunization system, increase coverage, equity of routine Immunization, and enhance the control of Vaccine-Preventable Diseases (VPD) (8)

Child immunization in Somalia is delivered through fixed, outreach and mobile services. 607 public and 29 private health facilities currently offer immunization services(9). International NGOs run 67% of public health facilities. In Somalia, a child is considered fully immunized “if the child received one dose of BCG vaccine, three doses of DPT, four doses of OPV, one dose of IPV and one dose of measles vaccine at nine months”(Figure 4) (9)

Age	Vaccines	
At Birth ¹¹ (up to 2 week)	BCG	OPV0
6 weeks (42 days)	DPT-HepB+Hib1	OPV1
10 weeks	DPT-HepB+Hib2	OPV2
14 weeks	DPT-HepB+Hib3	OPV3
14 weeks	IPV1	
9 months	Measles (MCV1)	

Figure 4: Vaccine schedule in Somalia

Due to prolonged conflict and insecurity, Somalia has one of the lowest immunization coverage rates in the Eastern Mediterranean (EMRO) (10). The DPT3 coverage rate is 42%, well below the global average of 86% for DPT3 (Figure 5)(11).

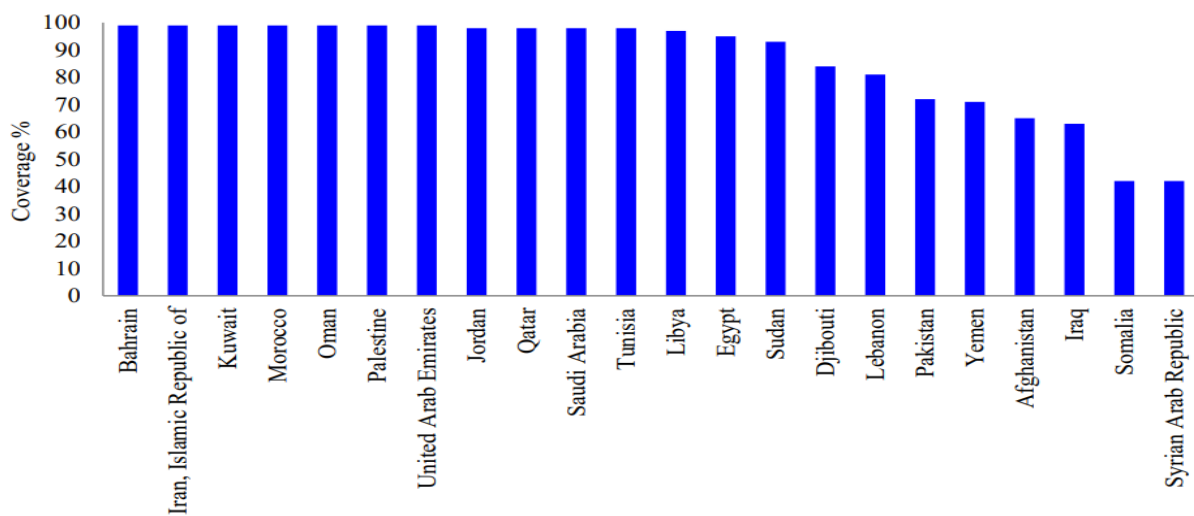


Figure 5: Coverage of the third dose of DTP3 EMRO region, 2016 (11)

1.7. Profile of Study area (Puntland state of Somalia)

The Puntland state of Somalia is the only state for which government has full legitimacy of control. The government governs around 90% of Puntland state territory. It is relatively secure, health facilities are accessible, and local and international organizations and humanitarian workers have access to implement immunization programs. However, The Somalia Health and Demographic Survey (SDHS) 2020 stated only 9% of eligible children (0-12months) are vaccinated, and 76% of children had not received any vaccine at 12 months (12). Because of this, Puntland state experienced the most frequent and most significant outbreaks of measles and circulating vaccine-derived poliovirus type (cVDPV2) cVDPS(16).

Puntland is a semi-autonomous zone of Somalia that is administered by the federal republic of Somalia (FGS). It is located in the country's north part. Bordered by the Gulf of Aden (north), Indian Ocean(south), central regions(south), Somaliland (northwest), and Ethiopia (southwest) (Figure 6) (13). The languages that are spoken in Puntland are Somali, Arabic, and Italian. All Puntland People are Muslim and adhere to Islam(13).

The economy of Puntland largely depends on livestock and fish exports. Remittances from the diaspora have also had a significant role and impact on the economy (14). The estimated total population of Puntland is 3.9 million and it constitutes a third of the country's geographical area. Most of the inhabitants live in rural agro-pastoral regions, with 52% having nomadic livelihoods. Since the establishment of the Puntland state, the security was stable. Security challenges include a border dispute with Somaliland, a self-declared state in the Sanaag and Sool regions and ongoing security incidents in some northern districts from the terrorist organization Al-Shabaab (14).

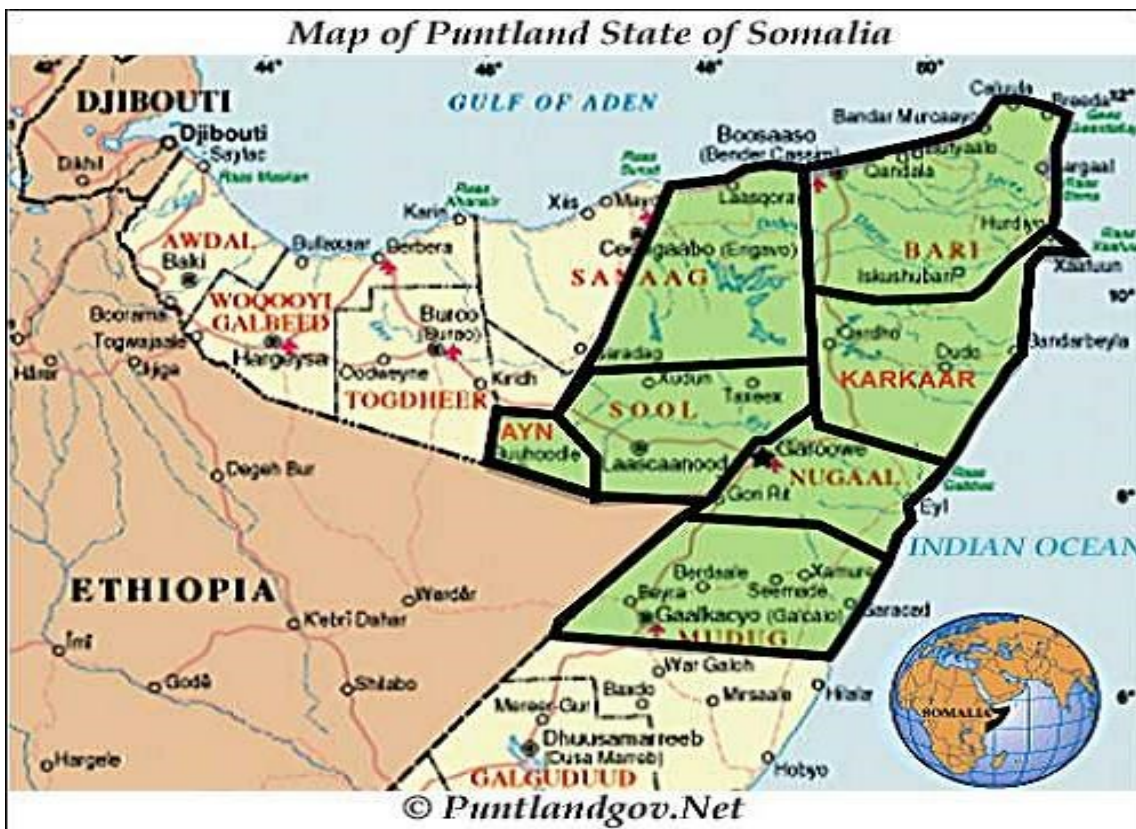


Figure 6: Map of Puntland state of Somalia(13).

2. Chapter two: Problem statement, Justification, Objectives

2.1. Problem statement

The importance of VPDs to child and infant mortality: Vaccine-preventable diseases (VPDs) are a significant public health concern in developing countries (20). In Africa, 30 million under-five children suffer from (VPDs); over half a million die from VPDs yearly, representing nearly 58% of worldwide VPD-related mortality (15). Vaccination is a successful, cost-effective public health intervention estimated to save yearly 2.5 million infants worldwide from diseases like diphtheria, tetanus, pertussis, and measles(16).

The immunization coverage in middle-income countries (LMICs) is low and below the expected herd immunity threshold, indicating low population immunity and high vulnerability to outbreaks of VPDs(17).

Low vaccination coverage: Globally, 19 million (target population 0-12months) were not vaccinated with DTP3 in 2019, which further increased to 22.7 million children in 2020. The greatest number of unvaccinated children were in low (4.5 million, 26%) and middle-income countries (12.1 million, 71%). Around 13.7 million (80%) unvaccinated children live in Gavi-eligible countries(18). Referring to the Eastern Mediterranean (EMRO) vaccine action plan, 2016–2020, 3.7 million infants missed receiving their third dose of the DTP-containing vaccine, of which 7.3% (Figure 7) live in Somalia, while Somalia accounts for 1.7% of the total population (679 million) of EMRO (11)

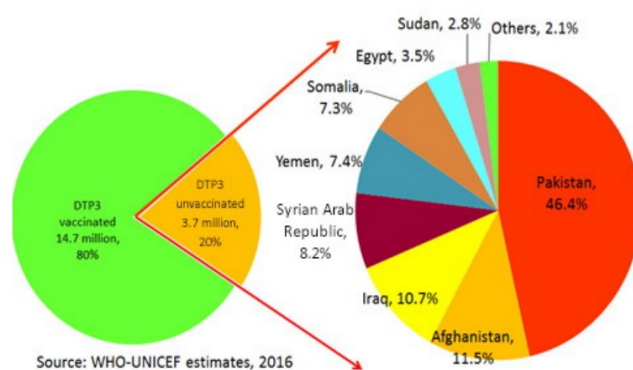


Figure 7: Unvaccinated children EMRO 2016 (11)

Somalia is ranked highest in infant mortality globally, with 80 deaths per 1000 live birth(19) 1 in 8 children (125/1000) die before they turn five(7). For instance, in the Eastern Mediterranean countries, Somalia has the highest infant mortality (80 deaths per 1000 live births) compared to Afghanistan, with 40 per 1000 as a fragile country(21)

According to Somalia's burden of disease data, half of the top ten causes of death and disability in 2019 were attributed to communicable diseases (Figure 8)(22). The burden of communicable diseases is responsible for more than 45% of life lost (28). Vaccine-preventable diseases such as measles, whooping cough, and pertussis pose a significant burden. They account for 20-30% of all deaths of children under five years in Somalia, indicating a low vaccination coverage (23). Along with infant mortality, there is also associated morbidity that reduces the quality of

life of many infants, impacts their development, and has financial implications for caregivers who must pay for healthcare to see that the sick child returns to full health (22)(23).

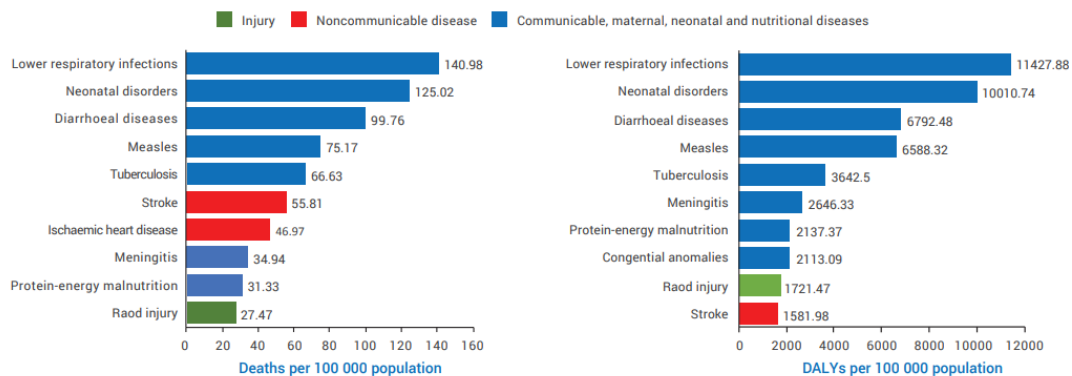


Figure 8: Top 10 causes of death and disability-adjusted life years (DALYs) per 100 000 Somalia, 2019(22)

In 2019, Somalia had one of the lowest immunization coverage rates globally due to prolonged conflicts, political instability, and fragile health systems (10). Approximately 6 out of 10 eligible Somali children (0-12 months) were unvaccinated against diphtheria, pertussis, and tetanus (DPT) (6). Referred Immunization Performance Report 2020 (WHO/UNICEF), out of 123 districts, 45% (55) districts reported coverage of 80% and above of DPT3 vaccine in 2019 compared to 29% districts in 2018 and 27% districts in 2017, while 39 (33%) reported 50–79%, and 29 (24%) reported less than 50% of DPT-3 coverage(Figure 9)(24) The DPT3 coverage rate is 42%, and measles coverage has remained at 46% for the last five years, well below the global averages of 86% for DPT3 and 85% for measles(28), lower than similar fragile countries, like Afghanistan, with 70% DPT and measles coverage (29). Coverage data like DTP3 always represent the vaccination status of children at age one year(25).

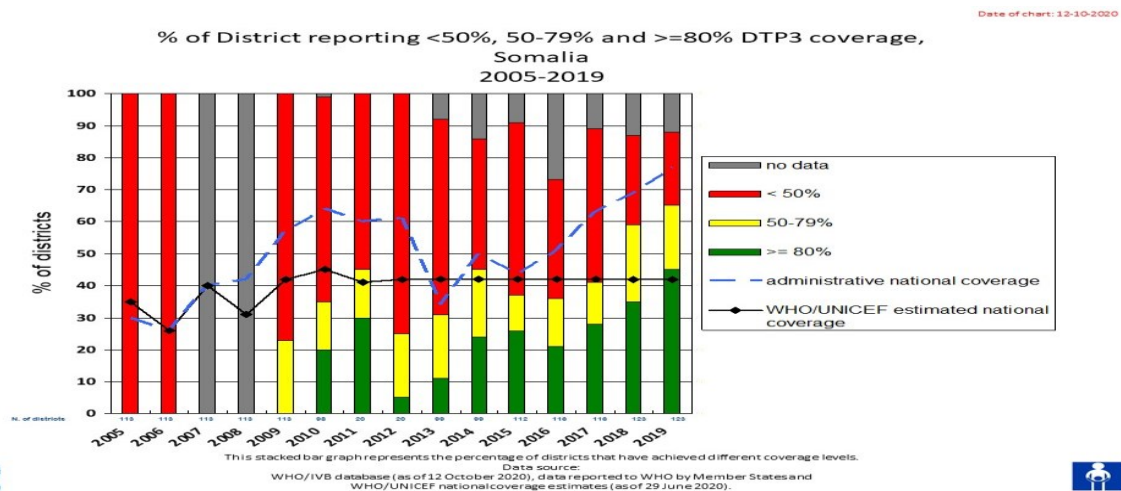


Figure 9: % of districts reported <50%, 50-7-% and 80% (24).

The Somalia Health and Demographic Survey (SDHS) 2020, which was conducted over the whole country, revealed that the Fully Immunization children (FIC) were 11%, while 60% had not received any vaccine at age 12 months (Figure 10)((26)

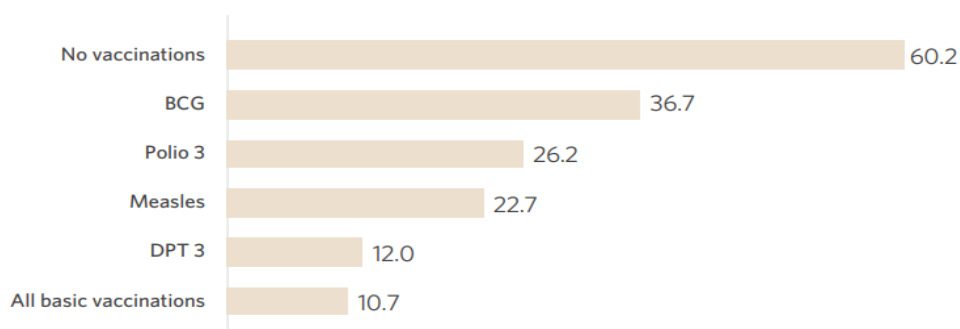


Figure 10: The Somalia Health and Demographic Survey (SDHS) 2020) (26)

Surveillance data on VPDs: In 2020, Somalia reported 14 circulating vaccine-derived poliovirus type 2 (cVDPV2) cases, of which four cases were reported from Puntland state compared with 15 cases reported in 2019. The continued detection of cVDPVs in Somalia indicates a significant population immunity gap predominantly because of children without access to appropriate health services in areas controlled by non-state armed groups, mainly in Jubaland, Hirshiballe and Southwest states (27)(28).

Also, in 2020, measles cases reported were over 554 per million due to low immunization, with Somalia having the highest rate compared to other fragile countries (Figure 11) (29).

Country	Reported Measles cases	Rate per million cases	First dose measles coverage (%), 2019 ²	First dose measles coverage (%), 2020 ³
Somalia	9068	554	46	46
Yemen	3629	119	67	68
Afghanistan	3628	91	64	66
Nigeria	12 341	58	54	54
Ethiopia	3039	26	60	58

Figure 11: Measles cases reported per million (29).

The overall risk for measles at the national level is assessed as very high. The largest measles outbreak in Somalia was recorded in 2017 (30). A total of 23039 suspected cases were reported in 118 districts across all six federal states, of which Puntland declared the most significant number. In 2020 a total of 2596 suspected measles cases were reported compared to 7494 cases in 2021. In the most recent outbreak of 2022, a total of 3509 suspected measles were reported, of which 1932 were reported from Puntland states, compared to 1114 suspected cases from the Southwest state and 141 cases from Jubaland state(31). In June 2022, the Puntland Integrated Disease Surveillance Summary (IDSR) reported 875 suspected measles cases, including 17 deaths (case facility rate CFR 2%)(30).

Some reasons for low coverage: Somalia's health system is still fragile, with a weak district health system. The immunization programme staffing at the MOH, and health facility level is inadequate, making it challenging to improve vaccination coverage to 80% as recommended by WHO(32). Additionally, the country faces prolonged conflict, and some parts of the country, mainly southern and central regions, are inaccessible. As a result, many communities have difficulty accessing routine immunization services (33). A study revealed that misconceptions and low trust in vaccines are critical factors for parents to refuse to vaccinate their children. Also, there are general inequalities in decision-making between men and women. Men are the final decision-makers in determining access to health services, including vaccination(32). The inequalities in vaccination coverage exist due to factors including socioeconomic status, mothers' education level, and the geographical location of the children when children in rural have limited access to the vaccinations(34). The high-risk groups in Somalia are those who live in hard-to-reach areas and urban slums, which include internally displaced people (IDPs) (9%), nomadic (26%), and rural 23% of the populations that are constantly moving and have difficulty accessing immunization services (32).

2.2. Justification

Immunization is one of the most successful public health interventions that can save millions of children and protect their health throughout childhood, adolescence, and adulthood(35). Increased vaccine coverage and uptake for LMICs significantly improved the survival of rate of infants by preventing and controlling many infectious diseases and outbreaks (36–38). Referring to ‘Modelling the impact of vaccination for the Immunization Agenda 2030’, around 51.0 million (95% CI: 48.5-53.7) deaths are expected to be prevented by vaccinations between the years 2021 and 2030, with the most significant proportion of deaths being attributed to measles, which accounts for 18.8 million (16.7-21.1). Around 11% (5.7 million) will be prevented in EMRO(39). Between 2000 and 2030, 69 million deaths are expected to be prevented in the 73 Gavi countries, with Somalia accounting for 0.7% (159,409)(37). Vaccination is among the most cost-effective intervention per DALY averted in low- and middle-income countries (40). Increasing immunization uptake can prevent the risk of mortality in VPDs; for example, Measles vaccination can prevent illness and death directly among vaccinated children and indirectly for those who are susceptible and unvaccinated through herd immunity to decreased transmission(40). Additionally, Immunization has socioeconomic benefits, including reducing the need for medical care and the cost of sick days for caregivers, increasing adult productivity and positively impacting economic growth(40).

The Somali government developed and launched a revised EPHS 2020 toward universal health coverage to achieve health-related SDGs. The aim of EPHS 2020 is to reduce the infant mortality rate from 80 to 50 per 1000 in 2030(19). Immunization is one of the priority public health interventions. In addition, the Somalia immunization policy 2020-2025 urged that at least 90% of infants in all states should be vaccinated (5).

In Puntland State, factors related to immunization uptake were not thoroughly studied. Qualitative research conducted in urban areas from the perspective of health workers and parents showed a lack of supply, inadequate infrastructure, and misinformation about the vaccine are among the factors influencing immunization uptake. However, these findings cannot be generalized as most of the population live in rural and nomadic areas (32). Therefore, understanding the factors associated with immunization uptake is essential for better-designed interventions.

Puntland state has experienced the most frequent and most significant outbreaks of measles and cVDPV in the country. In June 2022, the Puntland Disease Surveillance Summary (DSSR) reported 875 suspected measles cases, including 17 deaths (case fatality rate CFR 2%)(30).

The Somalia government urgently appealed to partners (academics) to participate in research, particularly regarding the immunization program(8).

This research will contribute to understanding the factors that influence immunization uptake in Puntland State and designing interventions to improve immunization uptake to attain immunization goals and maximize its impact. Additionally, this research will contribute to the existing body of knowledge by filling in the knowledge gap in Somalia as a whole.

2.3. Study objectives

General objective:

The overall research objective of this study is to review factors associated with immunization uptake in Puntland state of Somalia and provide recommendations for immunization program interventions.

Specific objectives

- To analyze population characteristics influencing vaccination uptake in Puntland state of Somalia
- To analyze health system characteristics influencing vaccination uptake in Puntland state of Somalia
- To critically discuss strategies implemented in Puntland to improve child vaccination and compare them with evidence-based interventions and best practices from other countries concerning vaccination strategies
- To provide specific recommendations to the government and other partners to adapt or design interventions that increase immunization uptake

3. Chapter three: Research Methodology

3.1. Study design

A literature review was made to answer the study objectives using published articles, grey literature, and evaluations on factors influencing immunization uptake. Also, a critical analysis was made of current interventions in fragile and LMICs to improve vaccination coverage for all eligible children in urban, rural, nomadic and IDP camps similar to Somalia to identify immunization programs' challenges.

3.2. Search strategy and keywords

Google Scholar and PubMed electronic databases were used to find articles published from January 2005 to date that provide an overview of Somalia's immunization program. This study utilized data from Somalia's 2020 national and Puntland state demographic health survey (DHS).

Boolean operators were used to combining relevant search terms in order to find relevant articles. Single or combination search terms included: EPI, Immunization, coverage, factors, determinants, child health, VPDs, health services, health systems, outbreak response, immunization strategies, Puntland state, and specific determinants used in the conceptual framework. Table 1 provides keywords and the search used to find the relevant articles. Snowballing was done through all references.

The abstract of each study was reviewed for relevance before accessing the full text of the articles. Subsequently, the references of related studies were looked through again to obtain other associated studies. Furthermore, an effort was made to find available grey literature from relevant evaluations, annual reports, and assessments of international NGOs and UN agencies by visiting their websites, including UNICEF, WHO, GAVI, and the Somalia ministry of health.

Table 1 keywords and searching strategies

	Issue or problem	Factors related terms	Areas and geographical locations
	AND		
OR	Immunization, vaccination coverage, quality, access to immunization, vaccine refusals, vaccine acceptance,	Sex, age, birth interval, Family size, clan, Family/household income, residence (urban, rural or IDPs), maternal education ; access to maternal reproductive and child health services (antinatal care ANC, postinatal care PNC, and delivery) Health seeking behenour, perception of vaccination, culture, religions, attitude toward health services, socio-cultural, Health systems, human resources for health, service delivery, supply chain and health information management HMIS. Immunization policy and strategies, national immunization, Polio, DPT, and Measles. Outbreak/emergencies, Universal health coverage Droughts, conflict;	Somalia, Puntland state of Somalia, low middle income countries, middle income countries, fragile countries, Sub-Saharan Africa. Conflict affected countries, Islamic radicalization/AL-Shabab, al daish/Alkaida/ (Afghanistan, South Sudan, Liberia,

Table 2 keywords and search strategies

3.3. Inclusion and exclusion criteria

The literature published from 2005 to 2022 was considered to present a current and historical perspective of various determinants of immunization uptake. Best practices and lessons learnt from past interventions were reviewed. Also, evaluations, annual reports, and studies that provide relevant statistical data on immunization coverage and influencing factors across states, zones, regions, and districts were included. Vaccines, as per Somalia's national immunization schedule, were considered. Guidelines or articles addressing specific serological or case management issues were excluded.

3.4. Study Limitations

Due to the limited availability of published literature on immunization in Somalia, the study relied on national representative documents published over the past seventeen years, including a demographic health survey updated in 2020, Gavi and a UNICEF report published in 2015. Only English-written articles were considered, while all articles in other languages like Arabic and Somali, were excluded. As the study focused on immunization uptake, introductions of new vaccines were also not included.

The validity of the figures generated mainly depends on the accuracy of the data used. Generally, the studies or surveys related to immunization coverage are based on parental recall rather than home-based records, which tend to have a risk of information bias. Furthermore, there were no specific related factors on individual levels in all states, zones and regions related to immunization coverage. The available data from the Somali states was inadequate to conclude on associations between sex and age. This is mainly due to the limited data collected at state levels.

3.5. Conceptual/Analytical framework

This study adopted a conceptual and analytical framework (Figure 12) for studying determinants of vaccination by Acosta-Ramirez et al. 2005 (Appendix 1)(41), which is based on Andersen's behavioural model of health services use from 1995 (Appendix 2)(42). The conceptual framework aimed to understand and analyse critical factors that influence the uptake of immunization services in the Puntland states of Somalia.

The analytical framework reflects two critical dimensions: demand (community-based) and supply (health system) of immunization uptake and its influencing factors to develop effective policies and contextual strategies to improve immunization uptake in Somalia.

The first dimension is community characteristics (demand side) which include children family characteristics related to immunization uptake, it includes three elements which include 1) Predisposing demographics: these are factors that affect the choice of available immunization and health services. 2) Enabling factors: these are factors that are related to the ability and resources needed to access available health services (immunization) for both community and individual levels; this includes the level of income, place of residence, level of education for maternal which affect the utilization and access of health services. 3) Need: These factors are related to how the general community and individuals perceive their need for immunization and related VPDs. These include social norms, attitudes, perceptions, knowledge and health-seeking behaviour toward immunization and health services.

The second dimension is Health system-related factors (Supply side): These factors are based on WHO's six health system building blocks (Appendix3)(43), including leading and managing health services and equitable distribution of health services, health service delivery,

availability, accessibility of immunization services, infrastructure, trained health personnel, supply chain and effective cold chain management and health information systems.

The conceptual framework also considered the external environment, which impacts the accessibility and utilization of immunization services. These include conflicts, disasters, migration, and displacement, unpredictable events that negatively impact the health system and community perspectives.

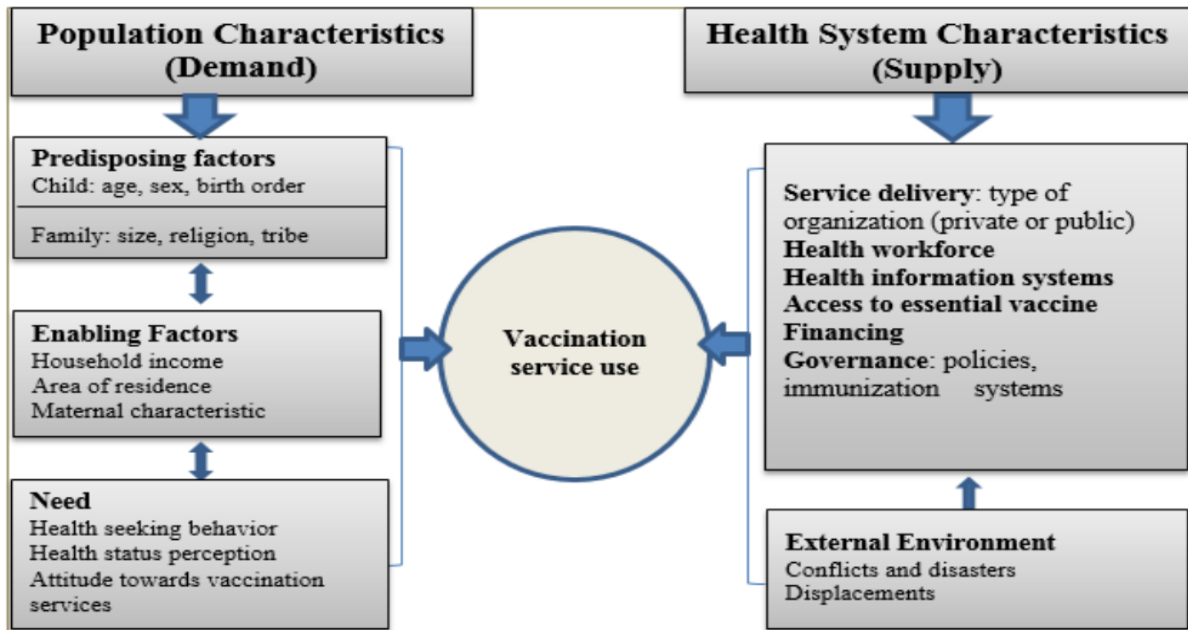


Figure 12: The analytical framework adopted from Andersen’s Behavioral Model of Health Services use (41)

To achieve the study objectives, the elements of the analytical framework were used to explore the two interlinked sets of factors, population characteristics (demand) and health system characteristics (supply), that influence immunization uptake. A critical analysis was made of current interventions to improve vaccination coverage for all eligible children to identify challenges of immunization programs as illustrated in Table 2:

Specific Objectives	Domains of the Framework	Subdomains or subthemes
To analyze community/population characteristics influencing vaccination uptake in the Puntland state of Somalia	Demand side	Predisposing factors (child's age in years, sex/gander, birth interval, size of the family, clan and regions. Enabling factors: family/household income, place of residence (urban, rural and Nomadic), Maternal factors Need-related factors: attitude, perception, knowledge and health-seeking behaviour toward immunization and health services.
To analyze health system characteristics influencing vaccination uptake in the Puntland state of Somalia	Supply-side	Health Service delivery, HMIS Proper management of vaccine and supply chain, Health resources for health External Environment (Displacement, Conflict)
To critically discuss strategies implemented in Puntland to improve child vaccination and compare evidence-based interventions and best practices from other countries concerning vaccination strategies	Vaccine strategies in Somalia	Current strategies to deliver routine immunization services in Puntland Demand creation, communication, and advocacy strategies in Puntland
To provide specific recommendations to the government and other partners to design interventions that increase		

Table 3 Application of the framework to answer the study objectives

The findings are organized into chapter four which will present the findings from the literature search based on elements of the analytical framework, addressing specific objectives 1 and 2). Chapter 5 will review immunization interventions in Somalia and discuss some evidence-based practices (addressing objective 3).

4. Chapter four: Findings.

4.1. Predisposing factors

4.1.1. Child

Child's age and eligibility

Age predisposes children to vaccinations, as parents usually go for growth monitoring and advice on their babies, and because eligibility for routine vaccines is usually below one year. In most LMICs, age eligibility for the measles vaccine is 9 - 12 months. Some vaccines give a better immune response when the child is slightly older, e.g., measles, but when measles is very prevalent, countries may decide to vaccinate at six months despite the lesser immune response(44). DHS 2020, found that the age of child is not a determinant to immunization uptake (12).

Child's Sex

The recent SDHS 2020 in Puntland state revealed a small difference in the proportion of vaccinated children by sex. The proportion of male children was (11.6%) compared to females (9.9%)(12). There is no sufficient data on immunized children by sex of all regions of Puntland state(12). However, a study conducted in the Banadir region of Somalia, a similar context to Puntland, showed that sex was a determinant of immunization status. This is somewhat attributed to the male value in the Somali context, in which childcare practices such as vaccination or health care favour the male child (34). Somalia is a patriarchal society. A boy child is favoured over a girl as he will be responsible for the house when he becomes older, whereas females are considered part of their husband's families (45). Male preference and discrimination against girls are observed in many parts of the world. A systematic review conducted in Nigeria, Pakistan, India, Turkey and Bangladesh on vaccination barriers stated that females are more unlikely to be vaccinated than males(46).

Birth interval and order

Some previous studies in Somalia stated that the order and birth interval of children in the household plays a critical role in the child's vaccination status. Children were less likely to be vaccinated if they were fourth and above compared to first and second (12). According to DHS 2020, around 40% of children receiving all basic vaccinations in Puntland state were first births, compared to 13% (4-5 birth order)(12). The findings contradict a systematic review conducted in Sub-Saharan Africa, which stated that families with more children are more likely to vaccinate their children than families with two children. This is attributed to mother's experience of time on the importance of immunization and diseases accrued due to lack of vaccination(47).

The birth interval of a child also contributes to lowering the likelihood of full immunization. The term birth interval implies the duration between two consecutive births. Short birth interval (<24 months) has long been associated with poor health outcomes, including infant mortality, while in contrast, long birth interval (>24 months) contributes to improving the health of mother and children, including vaccination coverage (16). The recommended birth interval in Somalia is 24 months. In Puntland, the median birth interval among women (15-49 years) is 21 months, the same as in all other states. The median increases significantly with age, from 12 months among mothers aged 15-19; this is linked to Somali culture, which promotes short

intervals (12). Around 12% of women aged 15-24 years had a birth interval of 12 months compared to the women aged 40-49 years who had 24 months. The chance of being vaccinated for the child was reduced if the interval was less than 24 months(12).

4.1.2. Family characteristics:
Size

A study indicated that family size is significantly associated with immunization status. As a child’s family size increases, the likelihood of being unvaccinated increases. Accordingly, children from bigger families had a higher probability of being unimmunized. Families with low socioeconomic status tend to have more children than high socio-anomic status, which affects immunization uptake and may have been a confounder(12).

The total fertility rate in Somalia is 6.9 children. Puntland state has the highest fertility rate in the country at 6.7 compared to Somaliland, 5.7(Figure 13) (12). In Puntland state, households are larger compared to other states. The average number of children in Puntland is 7.2 children, which is higher than Somaliland's 6.7 children(12). Factors associated with larger family size in Puntland state include early marriage and teenage pregnancy, while 35% of women in Puntland state are married in 20-24 years. As per the survey findings, the fertility rate was about twice as high for women with no education, at 7.2, compared to women with higher education, with 3.7 children (12)

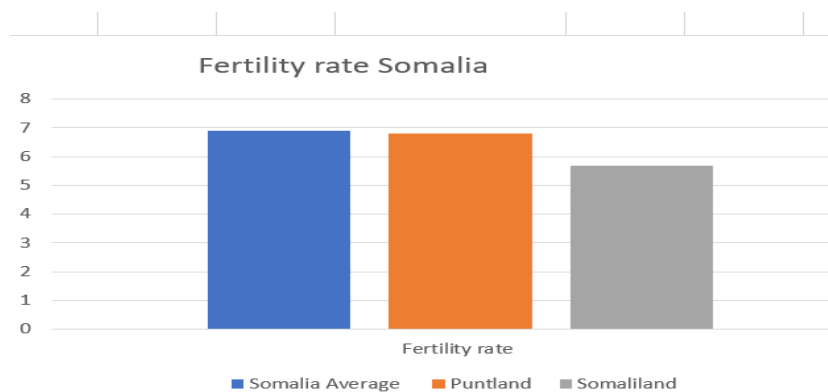


Figure 13: Fertility rate Somalia (12)

The Total fertility rate (TFR) among nomadic women is higher (7.5) compared to the TFR among women in urban areas (6.2). TFR, socioeconomic status and cultural factors tend to be associated, making it hard to say what, in the end, influences vaccination rates. Among the regions, the total fertility rate is highest in Sool at 7.9 rural areas, compared to Bari at 6.1 urban areas (12). This is further affected by the level of education of women. Information on birth spacing would assist Somali women in making better choices about how many children to have and promote better health for women and children. However, in Somalia, norms encourage short birth spacing, and women can’t access birth spacing services without their husbands' permission(48).

Religion

In low- and middle-income countries, anti-vaccination and refusal mindsets are prevalent and supported by religion(49). Barriers to the utilization of Immunization have been majorly correlated to Islamic religious views (49). Somalia is a 100% Muslim society, while religious leaders are essential gatekeepers and have a critical role in how society perceives preventive services, including immunization (34). A study conducted in the Mudug region of Puntland state 2020 indicated religion is a crucial factor in immunization uptake. People are reluctant or negatively perceive vaccinations, believing that vaccination is against the Quran and nothing can protect the person. “It is further sinful; only God protects you from diseases and knows what will come”(32).

Tribe

There are six main clans/tribes in Somalia. Four of these tribes, the Hawiye, Isaaq, Darod, and Dir, are collectively known as ‘Samaale’ tribes and share contiguous language and cultural bonds. These tribes constitute 75% of all ethnic Somalis clans. The other two clans, Digil and Rahanweyn, are known as Digil-Mirifle, mainly located in southern Somalia, and they are 20% of all ethnic Somalis. The Digil-mirifle clan speak Af-may, while the other four clans speak Af-maxaa of Samaale tribes. The remaining clans who fall outside these six are considered minorities(50) Dorod tribes reside in Puntland states.

No studies found how Somali ethnic groups and cultures are associated with the vaccination status of children. However, ethnic differences in vaccination coverage may be related to clashes and discrimination(51). The minority clans are disadvantaged compared to members of the majority clans. They may be excluded from accessing public services, including immunization, and subjected to discrimination in obtaining access to public services due to culturally distinct ethnic groups(52). Mohamed et al. state that clan conflict is critically associated with the vaccination status of children. The families move to secure areas while they miss vaccination and increase dropouts(32). Water, grazing, and land are deeply rooted causes associated with clan conflicts in Somalia, resulting in violence among clans and instability(53).

4.2. Enabling factors:

4.2.1. Household income

The family's socioeconomic status significantly influences immunization coverage and service utilization. Literacy and wealth have substantially impacted the likelihood of receiving a complete vaccination(12). The SDHS 2020 indicated that only 21% of children from the poor quantile completed a full vaccination course compared to 47% of the richest quantile(12). Although the vaccination services are free, the affordability of costs to reach health facilities has been significantly associated with Immunization status(65). Parents who could afford travel costs were two times more likely to immunize their children compared to parents who were unable. (AOR = 1.951; 95% CI: 1.238–3.076, P-value = 0.00456). This is because access to immunization services can be impacted by indirect costs linked to immunization services, such as time and the cost of transportation(54). Families in rural and nomadic areas are poorer compared to urban families. The Nugal region has the highest proportion of wealthier (22%), whilst Sool and Sanaag regions have the lowest proportion (8% and 7%), respectively(12).

4.2.2. Area of residence

The place of residence is a significant predictor of immunization coverage in Puntland state. In Somalia, around 23% of the population lives in rural areas, 26% in nomadic, and 52% in urban areas(2). In Puntland state, the Sool, Sanaag and Nugaal regions of Puntland host the largest nomadic population compared to the other areas of Puntland(2). The EPHS frameworks recommended that routine immunization services be available within a 5km walk from any community to address inequality in health service delivery (53). However, the national demographic health survey shows that only 0.7% of children in nomadic and 12% of rural children are vaccinated, compared to 15% of urban (Figure 14), indicating health service inequality(12). It is linked to the availability and accessibility of health services, further confounded by demand and supply factors overlap. For nomadic people, access to a trusted and regular provider may be less, but the nomadic people also share different cultural belief systems or misconceptions that may influence their vaccination demand (12).

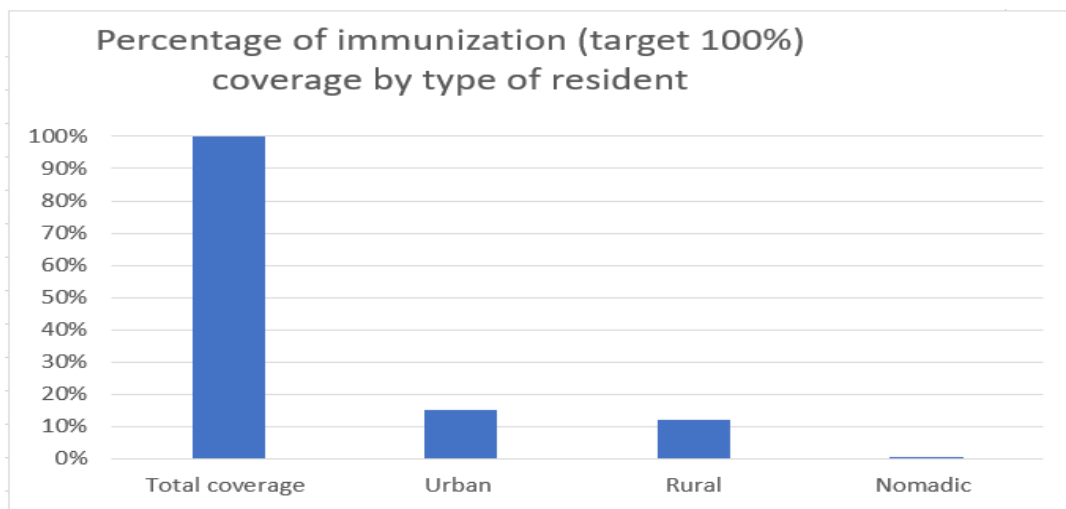


Figure 14: Percentage of immunization (target 100% by type of resident (12).

There are disparities in the percentage of immunization coverage in the Puntland regions. The immunization coverage of the Bari region was (13%), compared to the lowest number of vaccinated children who resided in the Mudug and Nugaal regions (6% and 7.6%) (Figure 15)(12).

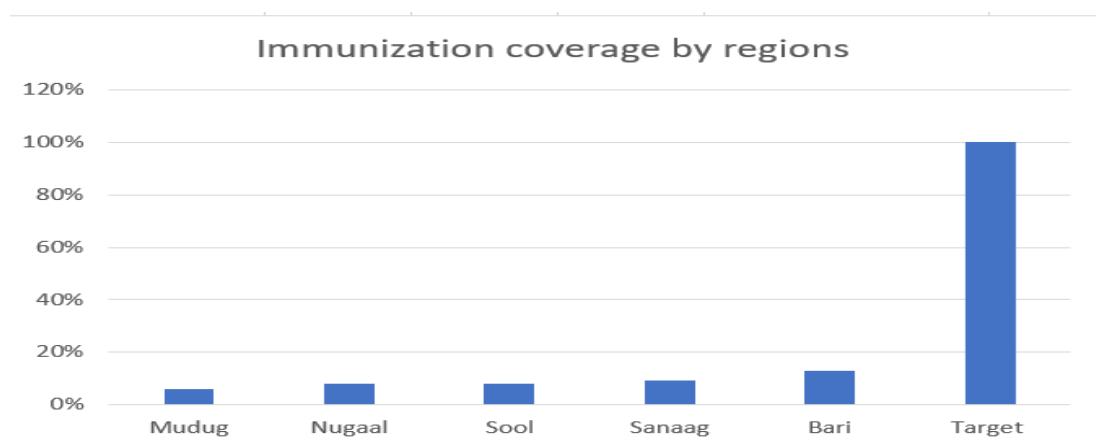


Figure 15 percentage of vaccinated children per region (12).

The long distance and poor road infrastructure are crucial barriers to access to Immunization in rural and nomadic areas(32). Women must walk an average of 15km of poor roads and terrain to access health services, including Immunization. Around 35% of DHS survey respondents reported walking for more than one hour to access the nearest health centre in rural(12).

4.2.3. Maternal characteristics

The studies have shown that maternal characteristics, including the mother's educational level, age, and marital status, significantly impact children's immunization uptake(55)(54). The children of educated mothers were 18 times more likely to be fully immunized than those of uneducated mothers(55). Educated mothers can easily access information about available health services, including antenatal care, place of delivery, the importance of vaccination, and how vaccination can protect their children from VPD(55). Educated women also often have higher incomes, are more independent from their husbands, they have fewer misconceptions and more rational attitudes towards vaccination. Education has links (confounders) to income level, attitudes, and place of residence. In Puntland, around 40% of mothers with secondary education vaccinated children, compared to 8% of mothers with no schooling(12).

Nationwide, Puntland state has the highest proportion (74%) of females aged six years and above who had never attended a school compared to other areas like Somaliland (65%)(12). The 82% of ever-married women in Puntland state had no education. About 33% of women aged 15-49 in Puntland are literate compared to 41% of Somaliland. Women's literacy substantially varies among the place of residence(12). 52% of women in urban are literate compared to 39% or rural areas. Nugal and Bari's regions have the highest literacy rate (43%), while Sanaag and Sool have the lowest (27% and 29%), respectively. Further evaluation of literacy levels increases with wealth status. Women from wealthier families are more literate at 66% compared to women from poorer families at 8%, affecting immunization uptake(12).

The age of the mother has a significant impact on child immunization. Children with young mothers are more likely to be vaccinated than children of older mothers. Young mothers are more likely to be educated and get vaccination information more quickly than older ones(54). This finding is in agreement with a systematic review conducted in Sub-Saharan Africa. This can also partly be attributed to workload and limited time as older mothers care for more children(47).

Marital status is associated with immunization uptake. In Puntland state, 11% of mothers are either divorced (7%) or widows (3%). Children with married mothers were four times more likely to immunize their children fully than unmarried caregivers (AOR=4.101, 95% CI: 1.062-15.835, P-value=0.041) (56). This is further associated with the level of education of husbands. The educated husbands were 1.755 times more likely to fully immunize their children compared to uneducated husbands [(AOR=1.755, 95% CI: 1.161-2.655, P- value=0.008(56)

4.3. Need

4.3.1. Health seeking behavior

The health-seeking behaviour and the utilization of other available health services are associated with vaccination uptake. This is linked to the level of knowledge and satisfaction of the community with health services and how they experience the risk and threats of disease. The more people experience the danger of a disease, the more they seek care(32).

In Somalia, without peculiarity to a specific region, socio-economic, cultural, religious, and societal beliefs play a critical role in health-seeking behaviour for women (32,48,51,57). Husbands are responsible for the household and decide on health-seeking-related issues, including maternal health care and vaccination, whereas mothers cannot refuse their husbands' decisions (32)(58)

In Puntland state, health service utilization is low. Only 31% of pregnant women received the first Antenatal (ANC) care visit; only 6% had at least four ANC visits, while 33% attended skilled birth attendance (SBA). Critical barriers reported by women for health seeking during pregnancy and delivery include financial constraints (65%), long distance (58%) to the health facility and obtaining authorization to use a service (42%); these factors may also affect immunization uptake(12)

The baby's delivery place influences whether the child is immunized or not(54). Children born at a hospital or health centre were 7.3 more likely to be immunized than those who were delivered at home. This can be related to the mother's education level and socioeconomic status. It is also influenced by the availability of health services in a specific area(55).

Figure 16 below explains the proportion of women who used post-natal service in Puntland state during the first two days following childbirth(12).

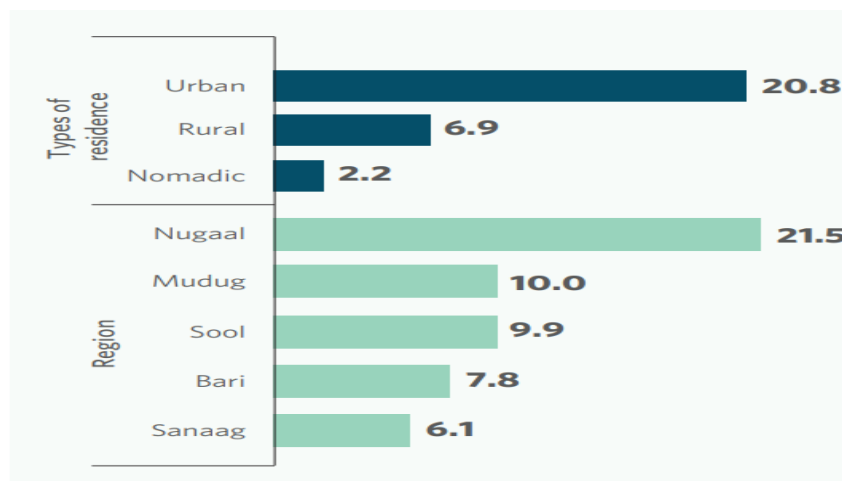


Figure 16: post-natal service in Puntland state during the first two days following childbirth (12).

In Somalia, women seek advice and remedies from informal providers, negatively affecting their attitude towards seeking vaccinations from public health facilities(12,48,58). Further, patients favour private health facilities more than public ones based on availability, quality and easier access. This is because public health facilities are open only in the morning while mothers are busy with day-to-day activities compared to private health facilities that open 11 hours per day(48). According to Hayir et, vaccine availability is significantly associated with immunization coverage. In some health facilities, there is no vaccine available at a health facility when mothers visit; consequently, mothers need to return to get the vaccine on time. Nurses don't open the vial at any time in health facilities. They use multiple dose vials to reduce wastage of vaccine, so they may plan special weekly vaccination days, which also increases efficiency but results in more "missed opportunities". Caregivers who received the vaccine in the health centre by the time of the visit were six times more likely to vaccinate their children

compared to parents who did not receive it by the time of the visit. (AOR = 6.147; 95% CI: 1.943–19.441, P-value = 0.002)(54).

4.3.2. Health status perception

The caregivers' perceptions of VPDs and vaccines affect immunization uptake(32). Many caregivers believed that vaccination would make a healthy child sick, which is an incorrect interpretation of the preventive role of routine immunization. For example, a qualitative study in the Galkoi district of the Mudug region in 2020 revealed that caregivers negatively perceive vaccines. They believe the vaccine is expired and contains harmful substances that can cause infertility and HIV. They further reported that there is no quality control in Somalia to check the vaccine quality(32). This belief is linked to minor vaccine side effects like fever, swelling, and pain, which the same children experienced after getting the vaccine. Caregivers who heard polio drops cause infertility later in life were more likely to refrain from vaccinating their child than those who had not heard (53% vs 31%)(59).

Caregivers with a positive perception of child vaccination were five times more likely to immunize their children than those with a negative perception of it (AOR=4.976, 95% CI: 2.183-11.340, P- value=0.001)(54). The caregivers' perception is linked to understanding the risk of VPDs. Caregivers who believe Polio is not a severe risk are less likely to vaccinate their children than those who see Polio as a severe risk (59). Mohamed et al. argued that community awareness raising and delivering immunization messages were insufficient, negatively impacting caregivers' perceptions (32).

4.3.3. Attitudes towards vaccination services and cost

In Somalia, vaccine refusals are the most profound barrier to immunization coverage(32). The attitudes and knowledge of caregivers play an essential role in achieving vaccination coverage. Caregivers who do not trust vaccinators are less likely to vaccinate their children. For example, in a study on vaccine acceptability in Somalia in 2014, parents who did not trust the vaccinators were more hesitant to vaccinate their children than their counterparts who trusted vaccines (49% vs 28%) (59). This is linked to a negative perception of caregivers of the vaccinators(59).

The attitude of caregivers is connected to the respectfulness, trustworthiness, and knowledge level of vaccinators. For example, 16% of caregivers who vaccinated their children during the last campaign did not trust the vaccinators. 17% said vaccinators were not respectful and caring about their children. Moreover, study participants reported that around 30% of vaccinators were not well trained and not knowledgeable. Those who thought vaccinators were not ‘very knowledgeable’ were less likely to vaccinate their children (7% vs 2%) than those who did(59)(32).

Community factors also play a role in immunization uptake. For example, caregivers who think their neighbourhood believes Polio drops are not good ideas were more unlikely to vaccinate their children than their counterparties. Furthermore, religious leaders and traditional birth attendance take the role in vaccination status. Caregivers who said religious leaders and traditional birth attendants in their neighbourhood believe the Polio vaccine is not good were more likely to be unvaccinated and uncommitted to vaccinating their children compared to their counterparts (37% vs 26%), respectively (59). Factors associated with caregivers' attitudes include child sickness and fatigue; mothers believe if the child has a fever can't be vaccinated (60).

4.4. Healthcare system characteristics

4.4.1. Service delivery and health Information systems

Lower immunization coverage in Somalia is linked to the frequency of vaccine stock-outs, which is attributed to the weak leadership skills of regional and district management teams. In Somalia, the Expanded Programme on Immunization (EPI) is managed by an EPI working group with support from the Somalia Support Secretariat (SSS)(61). In Puntland state, the EPI is decentralized into regions and districts under the leadership of the EPI director. Regional officers manage day-to-day activities at the regional level, while district officers manage the community level(61). The health care system in Somalia mainly depends on external aid. Non-governmental organizations (NGOs) on a national and international are the backbone of the public health service delivery system, and they are most prevalent in easily accessible urban areas. The health services delivery in Somalia is highly fragmented. Public health service provision mainly relies on national and international non-governmental organizations (62). In Puntland state, the immunization services are delivered through fixed (76%), outreach (20%), and mobile strategies (4%), applying the Reaching Every District (RED) approach to reach all children, including displaced ones(61). Through the GAVI fund, UNICEF and WHO provide operational and technical support(63). WHO implements polio eradication and measles control activities separately in all Puntland regions and districts(63).

Referring to Immunization service readiness in Somalia, as illustrated in (Figure 17), half (50%) of health facilities in Somalia provide routine immunization services, while only 13% provide an outreach service(64).

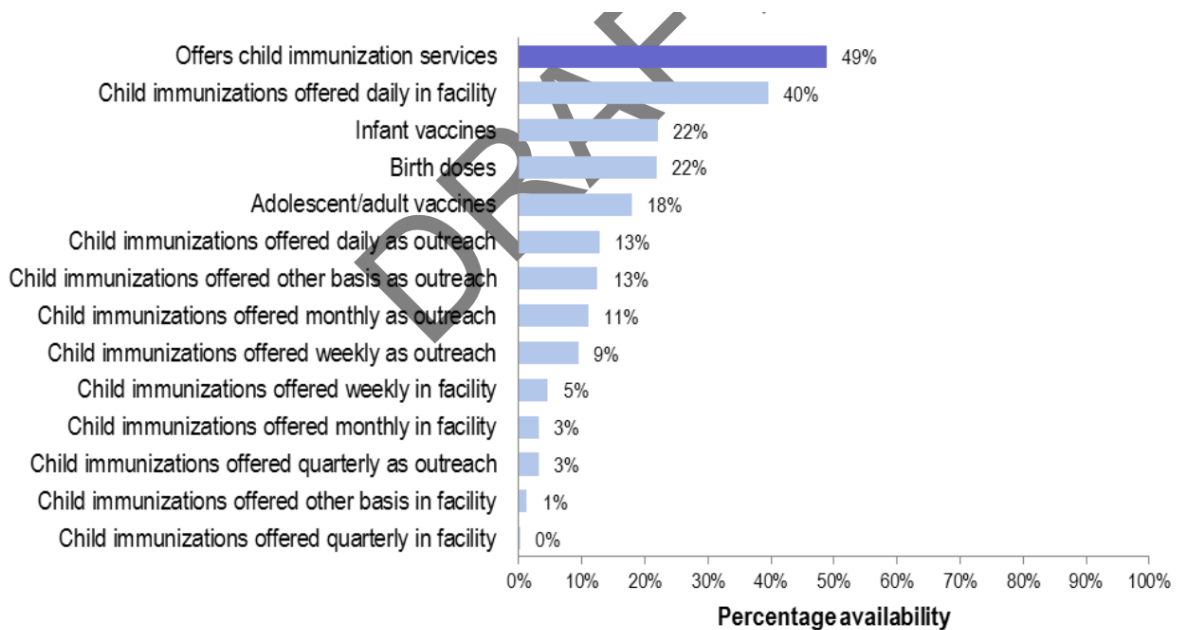


Figure 17: Immunization services readiness (64)

In Puntland, 85(37%) of 289 health facilities provide immunization services (Figure 18) compared to 40% in Somaliland. Most referral and health centers deliver child immunization services (89% and 87%, respectively)(64). Non-governmental facilities were more likely than governmental facilities to provide child immunization services (65% compared to 42%)(64).

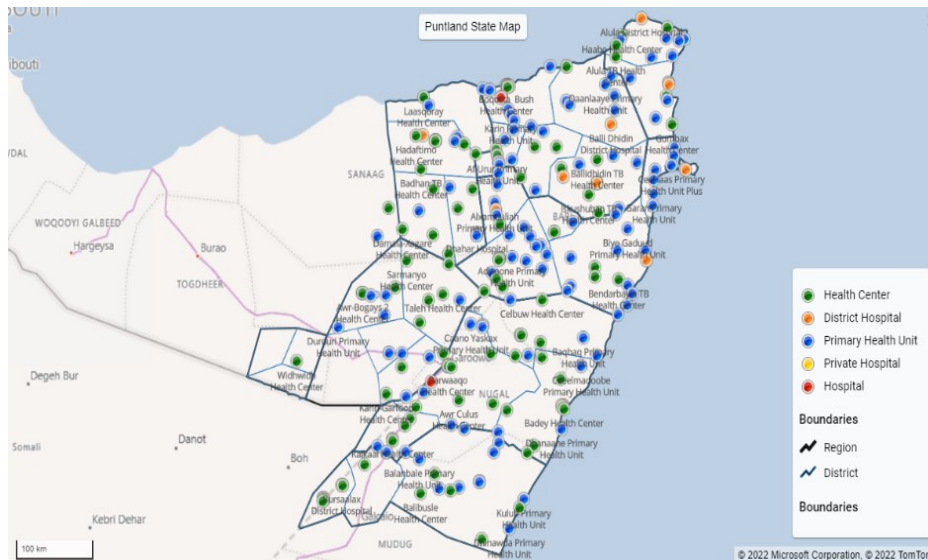


Figure 18: Health facilities providing immunization services (64).

There was inequality in services provision between urban and rural; urban facilities were much more likely than rural facilities to offer child immunization services (64% compared to 25%)(64). Regionally, the Nugaal region was most likely to offer child immunization services (51%) compared to the least likely area of Sool (20%)(64).

The immunization coverage in Puntland was substantially low; only 9% of children aged 12 months are fully immunized (Figure 19)(12).

Besides that, there is a high drop-out rate between DTP1 and DTP3 coverage. The dropout rate defines as “the proportion of immunized who had initiated the first dose of DPT but not completed the third dose of DTP”. It compares infants who received the first dose, indicating access, to infants who finished a third of those of DPT. The drop-out rate is an indicator to assess the quality of immunization services.

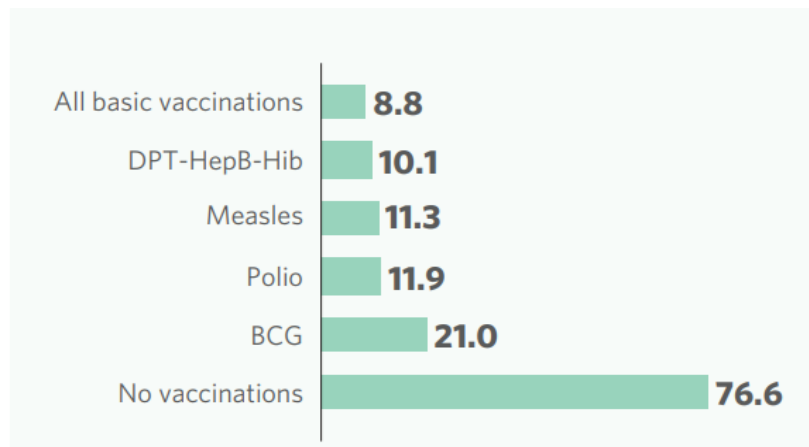


Figure 19: Immunization coverage Puntland state (12)

Of 23% of children who received the first DTP1 vaccine before the survey, only 10% completed DTP3 doses, which indicated poor quality(12).

Many caregivers only access DTP1 at the first contact point and never return to complete other doses of the immunization series. The high drop-out rate is attributed to insufficient sensitization, poor counselling for the mothers, a lack of defaulter tracing mechanisms, and poor record-keeping (63).

As per the health facility data's drop-out rate trends (2017-2019), most regions reported high drop-out rates, while Ayan, 55% and Sanaag, 39%, reported the highest drop-out rates due to clan conflict and population movement(Figure 20). This is also related to a lack of supervision and poor health management of immunization activities affecting the quality of immunization services(63).

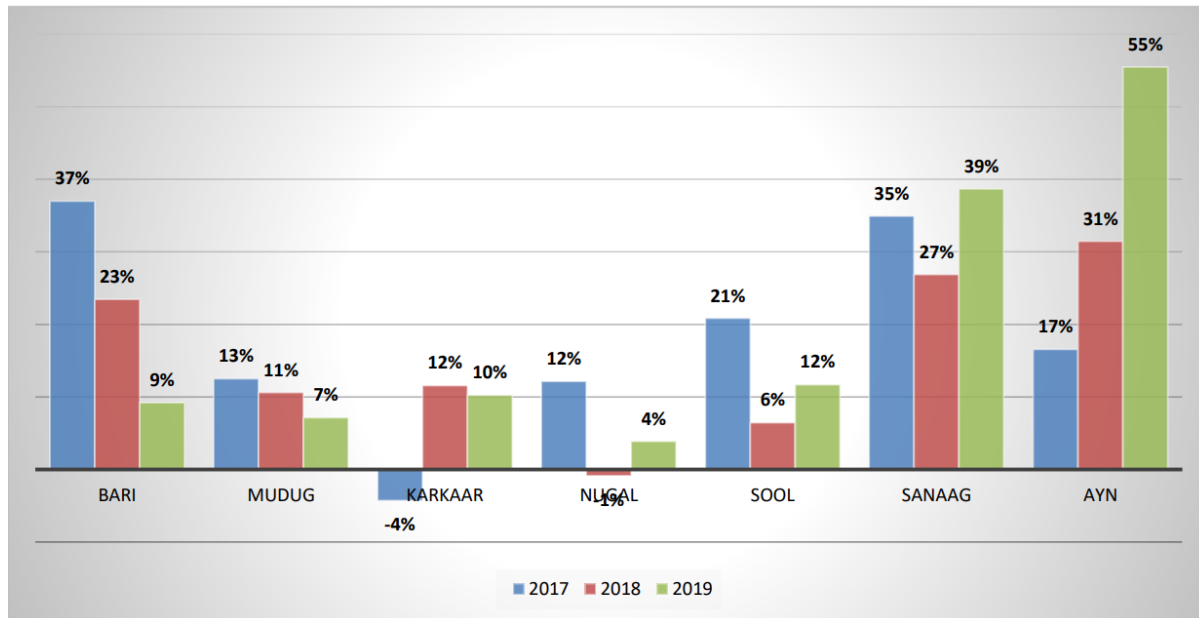


Figure 20: Dropout rate HMIS report Puntland(14)

Quality of Immunization data is essential to inform effective program planning at all levels of government. There is a lack of timely and reliable vaccination coverage data at the facility and district levels. Inconsistent use of registers and tally sheets hinders endeavours from achieving high vaccination coverage rates(65).

4.4.2. Health workforce

The regularity of vaccine supplies and cold chain maintenance considerably hamper immunization coverage in Somalia(66). The low immunization coverage in Somalia is linked to the availability of vaccines and other necessary supplies. For example, in the immunization facility readiness assessment 2016, only 20% of all facilities reported having all items required to provide child immunization services (Figure 21)(64)

UNICEF is responsible for procuring and transporting vaccines and other supplies into Somalia(61). In Puntland state, a central cold chain transports vaccines and supplies into the regional cold chain. Then region's cold chain distributes vaccines and supplies to the health facilities so that there is no vaccine storage at the district level (67).

While there is a well-structured supply chain in Puntland, frequent stock-outs are reported in health facilities due to poor vaccine utilization monitoring reports and a lack of wastage monitoring systems(67).

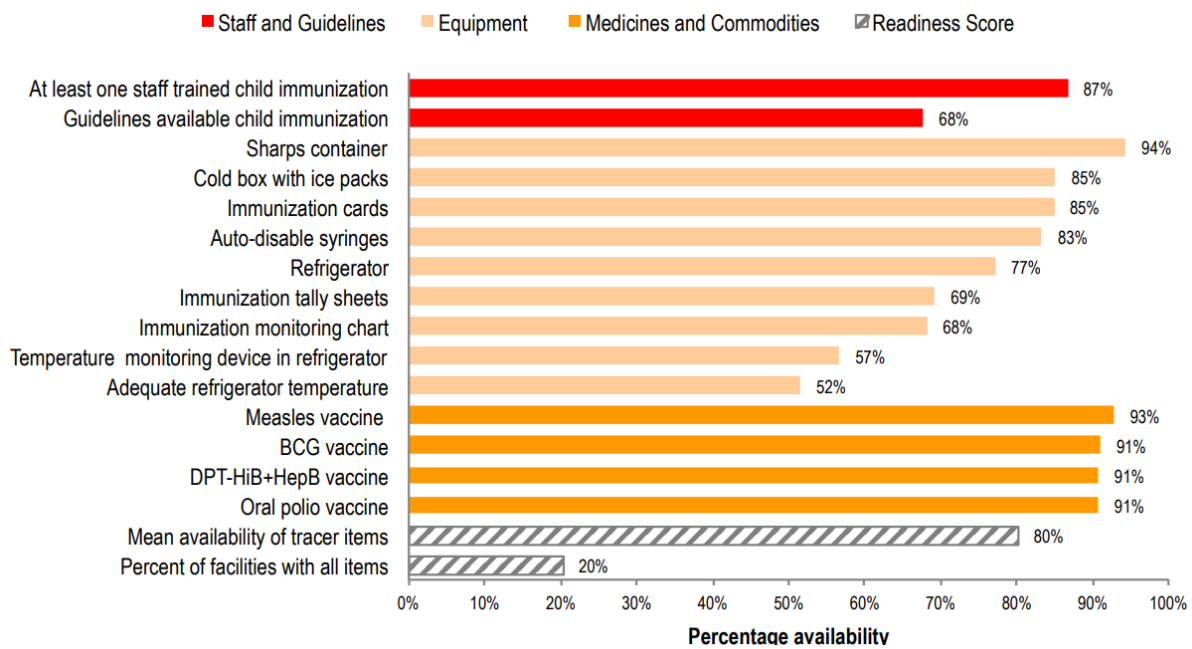
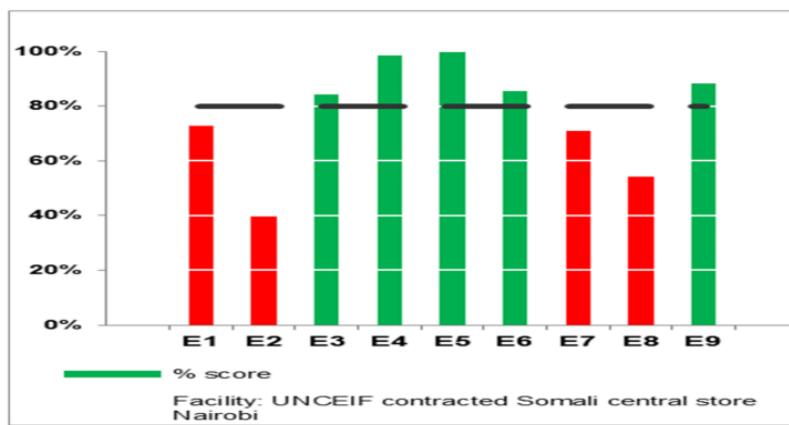


Figure 21 Items required to provide child immunization services (64).

Vaccine monitoring tools are available and used in all vaccine stores; however, data entries and reporting are incomplete. Evidence from the data submitted by the regional staff and follow-up visits to the regions indicated that the staff have gaps in their knowledge of stock control and monitoring tools. At the zonal level, wastage rates derived from the data are not very accurate. Additionally, there is no standardized reporting system in the health facilities, with some facilities reported in vials while others reported doses, creating inconsistency. The standard was to report doses(65).

According to the An Effective Vaccine Management (EVM) assessment report by UNICEF 2015, the overall score of EVM was 71%, and only five out of nine eligible criteria exceeded 80% (Figure 22). Vaccine arrival, temperature, distribution, and management were critical challenges in the report(70). Security and poor road infrastructural difficulties also affect supply management and cause several challenges in improving coverage in rural communities (66).



E1	Vaccine arrival	E4	Building & equipment	E7	Distribution
E2	Temperature	E5	Maintenance	E8	Vaccine management
E3	Storage capacity	E6	Stock management	E9	MIS supportive functions

Figure 22: Effective Vaccine Management (EVM) assessment report (66).

4.4.3. Access to essential vaccines

There is a critical deficiency of trained health workers amongst all the cadres of the health segment in Somalia, including Immunization (58,61,67). The health workers' density is 0.44 per 10,000, far below the global benchmark of WHO at 23 per 10,000. Puntland state scored the highest health workforce density at 0.52, compared to other states, for example, 0.43 per 10,000 population in Somaliland(64). The low density is worsened by the migration of many doctors, nurses, and midwives outside the country(61). The low immunization coverage is strongly related to the poor quality of immunization services in health facilities due to unqualified vaccinators hampered by poor health training institutions(67).

The shortage of health care providers in health facilities contributed to the long waiting period and demotivated caregivers, further contributing to low vaccination coverage(48).

As most of Somalia's population lives in nomadic and rural areas, unfortunately, there is an inequitable distribution of existing health workers between rural and hard-to-reach 15% compared to 54% of the urban areas; this further contributed to low immunization coverage(48). Lack of incentives, low motivation, high rates of absenteeism and frequent delay in salary payments have critically impacted poor quality associated with low immunization coverage. There are no retention strategies for health workers in rural and nomadic areas which further increases staff turn-off in health facilities(67)(58).

In 2016, the HRH policy was developed to increase the provision of community-based health care; however, the policy is yet to be fully implemented(68).

4.5. External Environment

4.5.1. Displacement

Poor access to primary health care services determines and explains immunization gaps between children of the host community and internally displaced ones(69). In Somalia, a combination of severe drought, recurring violence, political, social, severe water shortages, and economic factors resulted in a massive internal and external displacement of communities and livestock (70). Somalia is prone to natural disasters, which cause frequent displacement doubling with a weak responsive system(70). Every year there is a heavy loss of lives and properties due to these emergencies, which take all the attention of government and other stakeholders and create competitive prioritization for humanitarian efforts over developmental programs(63).

In 2021, UNICEF reported that 3.9 million people were displaced in Somalia(70). About 62.4% (544,000) of people were displaced because of conflict, 245,000 (28%) due to drought, 62,000 (10.6%) due to floods, and the remaining 22,000 displaced due to other factors. Furthermore, there are 109,989 refugee returnees from Yemen and 28,002 refugees and asylum seekers from Ethiopia in Somalia(71). Around 56.5% of Internally Displaced Persons (IDPs) in the country live in the central-south regions of Somalia, 22.5% in Somaliland, and 21% in Puntland. Most internally displaced persons (IDPs) were identified in the Mudug region of Puntland, Banadir, Lower Shabelle, Bay, and Hiran regions(63).

In 2021, The strongest storm on record hit the Bari region of Puntland state, lifting nine deaths, and displacing 180,000 people(72). In 2018, flash floods affected 13 districts, affecting 500,120 people, of whom 214,596 were displaced(73).

The recurrent droughts and floods trigger outbreaks, including measles, cholera/AWD, and polio (cVDPVs). In 2017 when the worst drought ever hit Somalia, polio and measles outbreaks were reported in all parts of the country due to multiple natural disasters, poor hygiene, lack of access to safe water and competing priorities for parents to complete Immunization(63). Furthermore, the influx and arrival of unvaccinated children into the IDPS settlements increase immunity gaps and the likelihood of an outbreak (63).

Population movements are an essential determinant of child immunization coverage. The population displacements make it challenging to find an accurate denominator and to set realistic targets for the catchment for health facilities (71). One reason is the difficulty in keeping track of rapidly travelling groups, which hinders the community's access to essential health services, including immunization(71).

In Puntland state, the consecutive seasons of below-average rainfall and the ongoing desert locust upsurge affect crop production and incomes, leading to humanitarian crises. The recurrent resource-based armed conflict between clans is adding to the impact of climate shocks (74). The food and water supply reduction will also result in price inflation compounding food security issues countrywide, especially in urban areas where the socio-economic impact of COVID-19 has significantly reduced employment opportunities for vulnerable populations (74).

4.5.2. Conflict.

Over three decades, the prolonged conflicts in Somalia resulted in complex humanitarian and longstanding emergencies which impacted already weak health systems in the country(61). The protracted conflict has led to severe deterioration of the population's health status, and much of the public health infrastructure has been destroyed, drastically affecting health service delivery, including immunization (61). According to the Multi-year plan, 2015-20, around 20 districts are inaccessible due to insurgency and political instability(61). The partner organizations find it challenging to implement immunization programmes. This further impacted planned supplementary immunization activities and monitoring outbreak responses (63). The ongoing conflict and armed insurgencies contributed to low immunization coverage, further increasing the population's unvaccinated children and leading to a large outbreak of Measles and Poliovirus infection(75).

In Somalia, the presence of Islamic extremist groups limits the delivery of immunization services to needy communities. Over 500,000 people are estimated to live within territory controlled by Al-Shabaab and remain largely out of immunization access(73)

Sanaag and Sool regions of Puntland, inhabited by nomadic communities, had experienced clan and armed conflict due to territorial disagreements, disrupted immunization services, increased number of susceptible children, and the likelihood of measles and Polio outbreaks(63).

5. Chapter five: Vaccine strategies in the Puntland state of Somalia

This section analyses the strategies that the ministry of health and other stakeholders implemented in Somalia to address the low coverage and how these strategies worked out and recommended a strategy to improve immunization based on other similar poor-resourced and fragile contexts.

5.1. Current strategies to deliver routine immunization services in Puntland

Globally, the critical Immunization strategies to improve efficiency and equity include routine immunization services, supplemental immunization activities (SIAs), and periodic intensification of routine immunization (PIRI) services like Child Health Days (CHD)) (82). Because of the poor healthcare infrastructure and limited availability of services to rural and hard-to-reach areas, Supplementary Immunization Activities (SIAs) are conducted annually in Somalia(83), in addition to the routine Immunization for eradication and elimination of poliomyelitis and measles, respectively; however, immunization coverage is still low (70)(85).

In Puntland state, immunization services are delivered mainly at fixed sites of static facilities. Parents come for the first vaccine doses, and they never return(65). Further, there is no effective defaulter tracer mechanism to trace missing children who never return for subsequent doses, which also impacts the quality of the immunization services and results in low coverage(65). Likewise, fixed health services don't carry out home visit strategies, increasing the drop-out rate. Despite 30% of the population in Puntland living in nomadic, rural, and hard-to-reach areas, only four mobile and few outreach services operate in Puntland state. This dramatically limits access to services by people in rural areas. Efforts have been made to map out the location of nomads and pastoralists, but there was no systemic way of reaching unvaccinated children. A strategy to get children in hard-to-reach areas is yet to be developed and implemented (73).

Solution and recommended strategies

Outreach services: Evidence from the Horn of Africa (including Somalia) polio immunization study indicated that strategies focusing on pastoralists could substantially increase immunization coverage of children in nomadic areas(34). In a context like Somalia, where population movement and migration are exceptionally high, strategies to reach hard-to-reach communities are needed(84). The study showed that unvaccinated children decreased from 44.6% in the preintervention period to 19.5% in the study area of Somalia. Also, children receiving between three and four oral polio vaccine doses increased from 12.5% to 21.7% between the two periods(34). This is attributed to understanding the classification of the community (nomadic, rural, pastoralist), their movement dynamics, values, and beliefs and how to create trust through respectful communication. Furthermore, mapping nomadic communities' water points and livestock markets is the critical entry point to conducting awareness activities and sharing vaccination-related information (84).

According to the Gavi report 2019, outreach activities to urban cities which targeted peripheral villages and IDP camps would increase immunization coverage. Gavi supports ten districts to conduct outreach services in Puntland state. Evidence from the reports showed a substantial increase in immunization coverage in Gavi-supported communities for all antigens compared to non-Gavi-supported districts (Figure 23) (62). The outreach activities are an effective strategy to enhance the health facilities to reach target children. The intervention entails health facility workers to develop outreach plans and conducting weekly outreach activities while reporting outreach data to health facilities. The intervention will focus on urban slums, IDPs

camps and remote villages from health facilities (67). Double counting will be avoided using the same facility reporting tools (62).

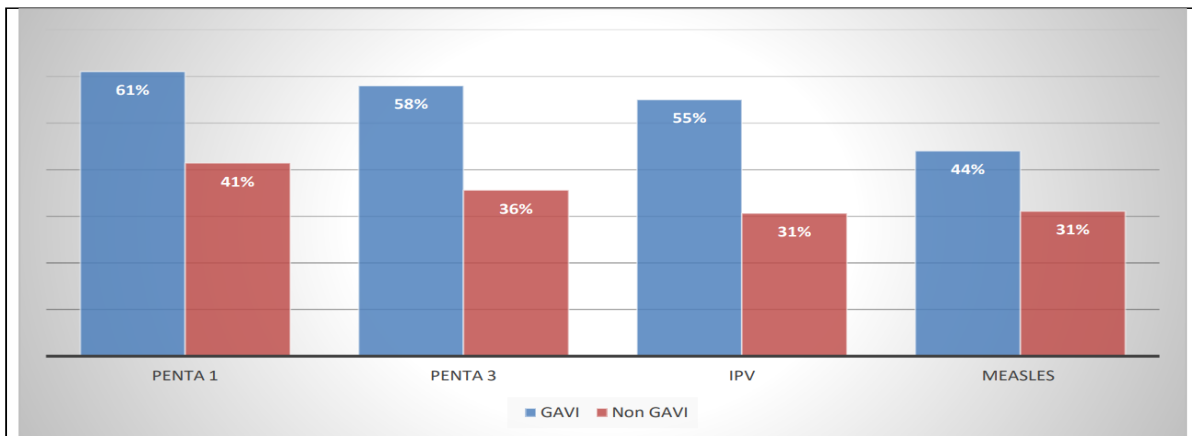


Figure 23: Comparison of GAVI and Non-gave supported districts (62).

5.2. Demand creation, communication, and advocacy strategies in Puntland

The Ministry of Health in Somalia developed a national communication strategy that expresses the goals, channels, and activities for increasing demand for health services(85). However, it has yet to be fully implemented for the benefit of routine immunization. UNICEF, WHO, and NGOs support advocacy and communication activities, including training for health workers, printing materials, education, communication, and information. Vaccination Week is conducted annually as part of the global and regional strategy. Despite these efforts, community involvement and utilization of immunization services remain very low. NGOs conducted Interpersonal Communication (IPC) training for the MCH health staff. The local FM radio airs vaccine-related messages (62). However, according to SDHS 2020, 88% of the population in Puntland doesn't access any form of media (newspaper, radio, or television) at least once a week(12). A lack of community involvement and empowerment led to low demand for services and, thus, low utilization of immunization services. Even though vaccinators have been trained in interpersonal communication, they don't seem conversant in communicating with mothers effectively. Mothers don't receive proper counselling about the importance of the vaccine and its schedule, as well as possible adverse events after administration of vaccines (AEFI) and what steps should be taken in case of AEFI, which further impacts the completion of immunization services(44).

Solution and recommended strategies

Face-to-face communication. Evidence from low-middle-income and fragile countries suggests that Face-to-face intervention to educate/inform parents may advance vaccination status (risk ratio (RR) 1.20, 95% confidence interval (CI) 1.04 to 1.37)(86). When a lack of awareness or misconception of vaccination is a barrier to vaccination uptake, face-to-face intervention is an effective strategy which can be used in any setting. Somalia is a primarily oral society, and people understand concepts better in discussions(34). Furthermore, around 88% population in Puntland don't access any forms of media (newspaper, radio, and television) at least once a week. It allows parents to raise their concerns regarding vaccination by asking questions and clarifications(86). It can occur in one-on-one interactions or in small groups of people. Face-to-face communication is essential when communicating with someone who is illiterate. Volunteers, advocates, and community health workers conducted it at the community and facility levels., Most trusted groups, like religious/clan leaders, could be involved to help

parents understand their concerns(87). The goal of the information given to the parents is to change or support specific health behaviours to vaccinate their children on time and as recommended. However, behaviour change is complex, and several theories outline potential factors that may predict or influence an individual's behaviour. According to The Health Belief Model, HBM, the decision to act or not - is a product of several variables: perceived severity (of vaccine-preventable diseases (VPDs)), perceived susceptibility (of one's child to VPDs), perceived benefits (of vaccination); perceived (side effects)(88).

Evidence shows that using trusted people in the community promotes the community's level of interaction and participation(89). In Somalia, the social system is described by hierarchical clan units, which are the ruling body of most nomadic communities; therefore, using them as an entry point is a successful engagement with the pastoralist community. Clan leaders are identified as the most legitimate leaders by their clan members. They are the prime force for stability and conflict resolution between clans (83).

6. Chapter six: Discussion

Despite a relatively stable security situation and smooth operation of immunization programs in the Puntland State of Somalia, full immunization coverage is only 9%, while 75% of eligible children are without any vaccination. This research reviewed both demand and supply factors associated with immunization uptake. Maternal education, income, nomadic life, attitudes and perceptions on the advantages and disadvantages of vaccines and VPD's were the most important demand factors. The attitudes and perceptions are shaped partly by education, rural residence, ethnic group, and religion. Availability, accessibility of immunization, infrastructure, trained personnel, and supply chain are key supply factors. These factors are interlinked and influenced by external factors such as conflict and disasters related to displacement.

Demand side factors: The eligible immunisation age is below one year; there are no significant findings on how age could determine immunization uptake. However, low birthweight and preterm children are more likely to be unvaccinated as parents don't take them to health facilities to receive their vaccination.

The quantitative analysis of the 2020 SDHS indicated a very slight difference in coverage rates among boys and girls (11.1% and 9.9%). Data at the substates level was not adequate to identify differences between the Puntland state and other states of the country. Further studies revealed that female children are less likely to be vaccinated compared to male children. This is attributed to male values in the Somali context. Somalia is a patriarchal society in which childcare practices such as vaccination or health care favour the male child, who will be responsible for the house when he becomes older. This is also attributed to mothers' beliefs that immunization will negatively affect their girls when they reach childbearing age. Thus, vaccination should not be given to protect her fertility which is associated with low immunization uptake for females.

Other factors like (family size, birth interval, birth order, and residence) are associated with immunization coverage. Somalia has among the world's highest fertility rates at 6.9 children. This is attributed to the Somali culture and norms, which promote short birth spacing and believe that women should produce more children; women are respected if they have more children. According to SDHS 2020, the women in Puntland state prefer to have at least 11 children. There is not much difference in the number of children between rural/nomadic and urban families. The bigger rural and nomadic households (7.2 children) compared to the urban families (6.7 children) are attributed to low-socio-anomic status, educational level, early marriage, and teenage pregnancy. At the same time, 35% of women in Puntland state are married at 15-24 years. Uneducated, low-income families residing in rural areas or being nomadic are more likely to have more children than wealthy, educated, or urban families; these interlinked factors which further impacted by the external environment (war/conflict; natural disasters) and its nefast impact on a weak health system affect immunization uptake.

Religious belief was one of the factors affecting childhood immunization uptake in Somalia. Islamic education and ideas form most people's understanding of immunization and its prevention mechanism. People believe fate and what God has granted can only happen to their children, significantly lowering immunization coverage rates. This could probably be due to their beliefs on how their Gods look upon vaccination and further influencing involving religious with false beliefs and misinformation about the vaccine that religious networks spread. For example, the views that vaccines compose a toxic substance that can cause infertility and HIV diseases which can negatively harm the female reproductive system. Religious leaders are highly regarded and commonly considered and accepted as guardians.

They provide definitive advice to their respective communities. As a result, getting them involved in immunization activities will boost the general public's openness to and use of vaccines.

In sub-Saharan Africa, the family's economic status significantly affects immunization coverage(47). Children from families of the lowest quintile are less likely to be immunized compared to those from the highest quintile. This is because lower-income families encounter challenges in reaching a health facility. This includes transportation difficulties and indirect costs related to transporting, or other costs, like food, while travelling to a health facility. Also, lower-income people are more likely to have lower education. Rural communities have less physical access to services and adhere to more traditional belief systems (47).

Furthermore, vaccination will not be the priority when the household suffers food and resource shortages. The Sanaag and Sool regions had the most significant number of poorest households. Therefore, the studies showed that conditional financial incentives for low-income families significantly increased the use of immunization uptake (90). This could make it possible for the Somali government and international NGOs to design a multi-sectoral approach by integrating humanitarian projects of health nutrition and livelihood projects to maximise the impact, efficiency, and effectiveness of reaching financially disadvantaged communities

In data comparison, the geographical residence was most profoundly associated with immunization uptake. Coverage across rural and nomadic areas was extremely low. Children living in urban regions were more likely to be immunized than those in rural and nomadic communities. This may almost certainly be attributed to the reality that parents in the main cities are more likely to go to school, which positively increases their knowledge of the advantage of childhood vaccination uptake compared to mothers living in rural areas. Also, the nomadic people may frequently move from one place to another, where access to immunization services may not always be possible. Therefore, understanding the nature of nomadic, rural, and pastoralist movement dimensions and how to create trust through respectful communication is crucial to reach them. Thus, strategies are needed to reach nomadic and rural communities(91–94).

Various interplaying socio-economic and cultural factors have a role in determining women's health-seeking behaviour in Somalia. The deep-rooted traditional and sociocultural norms make women and girls considered inferior to men. They nullify their participation in education, health services, decision making and control over resources in the house. Around 74% of females aged six years and older never attended a school. This is related to cultural practices that encourage women to stay home and take care of children while men have overall responsibility. The husbands' decisions, cultural traditions, and norms limit women's access to health services.

Factors such as the mother's educational level, age, literacy, marital status, access to antenatal care follow-up, place of delivery and positional check-ups also influence the goal of full immunization coverage. The possible explanation would be the changes accompanying maternal education, such as attitudes, practices, and beliefs, as well as increased autonomy and control over household resources, which increase the healthcare seeking of the mother. Age also is a significant factor in immunization uptake. Children from mothers under 25 who live in urban areas are more likely to receive all recommended vaccinations. This is linked to the young being more educated than older mothers.

Evidence shows that in a low-resource setting like Somalia, cost-effective interventions such as home visits by trained community health workers are linked to improving maternal health care, which could further enhance immunization uptake. As the utilization of available health services is low, it could promote access to ANC, health centre delivery, and early postnatal care PNC in health facilities. These further increase immunization uptake(95).

Many studies stated that fear of vaccine side effects and lack of confidence in vaccine safety could negatively affect immunization uptake. Also, parental factors, such as health-seeking behaviour factors, perceptions, views and beliefs about immunization and other essential services, can influence the possibility of receiving all recommended vaccinations. This is further linked to the community awareness level. Also, community network and how they understand the risk of VDPS is also associated with immunization uptake. Studies revealed that when a lack of awareness or misconception of vaccination is a barrier to vaccination uptake, face-to-face intervention is an effective strategy that can be used in any setting. The group sessions approach is a very effective strategy to create demand and empower caregivers. Somali people are an oral society, and this approach (meetings, open discussions, questions, and answers) could increase caregivers' knowledge and be an excellent information-sharing mechanism. Also, involving religious leaders' men and traditional birth attendance is useful.

Supply-side factors: Over three decades, the protracted conflict in Somalia negatively impacted the health system from different angles, including infrastructure, physical access to health services, health workforce, policy, and regulatory formulation. The impact of the drought and the ongoing conflict have been devastating, and the situation continues to deteriorate. Physical access to immunization services and a disastrous human resource shortage have influenced the EPI program's proper management. Further poor supply management, particularly stock keeping and cold chain, poor coordination with concerned stakeholders and lack of community strategies affect people's expectations and trust, reducing demand and further worsening the functioning of health systems.

The health sector strategic plan HSSP 2017-2021 was developed to build governance capacity in response to this challenge of governance and leadership(96). However, the creation and rollout of different HSSPs in the states of Puntland and Somaliland affected the implementation of immunization strategies and humanitarian aid response. This is attributed to the lack of clear roles and responsibilities of the federal government and member states in the health arena. The fragmentation of service delivery and ineffective coordination of involved stakeholders further deteriorates health service delivery in Somalia. Evidence from fragile contexts like Somalia showed that contracting out with non-state actors (NGOs) is the best option and a good strategy to expand access to immunisation services when the government has a limited capacity to provide health services(76). It will harmonize external support and donor coordination and reduce fragmentation. Afghanistan has made tangible achievements in immunization despite insecurity and limited governance capacity, achieving 70% of DPT/Pentavalent and measles in 2015(78)(79).

As a lesson from Afghanistan, the Somali government can introduce contracting out health services to local and International NGOs with solid experience in health service delivery and prior knowledge in the local context (81). The contracting will improve the quality and efficiency and increase the accessibility of immunization to all regions of Somalia(77). The key contracting activities will include salary, training, and capacity building of health workers through supervision, procurement, and distribution supply(77)

Strengthening leadership in the health system was recognized as a critical component of Somalia's health system support. In Liberia, after a prolonged civil war, strong health governance and leadership significantly improved child health services (97). Afghanistan also made considerable progress in strengthening governance programs to equip district and regional management teams to lead better and manage the country's health system(98).

Human resource is the worst element of Somalia's health system building blocks. Little evidence was found on building a healthy workforce in fragile countries (98). However, building local capacity and equal distribution of health workers in urban and rural is a critical priority in Somalia which needs a long-term commitment and adequate resources. Evidence showed that such critical challenges could be addressed by contracting out local and international NGOs. A community-based female health worker model implemented in several countries has also been piloted in Somalia to build local capacity. Nevertheless, its impact has yet to be assessed.

The governments of countries with prolonged conflict with the same challenges as acute shortage of health staff and sufficient urban/rural disparities have prioritized strengthening the health workforce, particularly community health workers(99). Through developing strategic plans which aimed to improve the status of health staff, increase the number of staff in health facilities, staff retention and enhance local training institutions. Countries like Sierra Leone and South Sudan recognize the importance of prioritizing the need to strengthen human resources for health in quantity, quality, and geographical distribution (99). Building and upgrading pre-service education and training provisions were viable solutions to address the shortage of health workers(100).

Inequality between rural and urban is critically associated with immunization coverage. The health services in Somalia largely depend on the support of INGOs funded by external donors. As a result, aid has been focused in areas where access has been possible, leaving many people susceptible and without access to health services, including immunization(101). The availability of immunization services is a typical driver for vaccination uptake. A similar challenge has been found in fragile states such as South Sudan, Sierra Leone, and Zimbabwe. Evidence found that community-based programming initiatives successfully implemented in other developed countries like Pakistan, Nepal, and Bangladesh were a solution to address such inequalities in health services delivery. Liberia, a similar country with prolonged civil war, made a tangible achievement in child mortality. The government prioritized maternal and child health, implementing an integrated package of health services. The key interventions the Somali government can learn are enhancing intersectoral collaboration, using outreach campaigns, improving health workers' capacity, training traditional birth attendance, and improving referral mechanisms (97).

Study limitations:

As a literature review conducted by a sole researcher, this study has some limitations, described herewith.

Evidence gap: Due to the limited availability of peer-reviewed articles on immunization in Somalia, the study relied on national representative surveys like DHS and other available reports. Some of the studies or surveys of immunization coverage used for this study were based on parental recalls rather than home-based records, which tend to have a risk of information bias. The available data from the Somali states was insufficient to conclude on associations between sex and age. There is no sufficient data on immunized children by sex of

all regions of Puntland state. Most studies were conducted in urban which can't be generalizable to rural areas. Furthermore, studies did not analyze the confounders on their variables, making it difficult to conclude how each variable influenced coverage independently.

Interventions: The current interventions in Somalia and fragile LMICs to improve vaccination coverage were analyzed based on the information gained from the available resources and how they fit the study objective. For this reason, a chance of bias may exist, as all interventions were not fully analyzed.

Analytical framework: Due to the overlap between various factors, for example, culture influences attitude and perceptions, and perceptions are further influenced by enabling factors (income) and by supply factors, which made the analysis challenging to conclude how factors are interlinking and how they can be actionable.

7. Chapter seven: Conclusions and recommendations

7.1. Conclusion

The study addressed the factors influencing immunization uptake on both the demand and supply sides and critically analysed current interventions to improve vaccination coverage in the Puntland state of Somalia. The immunization coverage of Puntland state was extremely low in all regions. Even if urban children show a slightly higher coverage, it remains unacceptably low. The situation is even worse in nomadic populations. This is a crisis, given the importance of vaccinations for child health and mortality in Somalia.

It can be concluded that the low immunization uptake is strongly associated with several factors related to demand and supply. Socioeconomic status, place of residence, maternal characteristics, and religious affiliations are key determinants from the demand side that influence immunization uptake. These factors were found to be interconnected at various levels. For example, education affects a mother's socioeconomic status, which tends to influence exposure to information of immunization information. This study establishes the differences in access are influenced by inequities between rural, nomadic, and urban populations. Additionally, sociocultural factors (gender, family size), socioeconomic factors (status, education) and knowledge factors (exposure to immunization message) impact perception factors (perceived risk of VDPS and importance of vaccination).

The supply side determinants are availability, accessibility of maternal and child health care services, poor health infrastructure, lack of trained personnel, and supply chain. Both demand and supply factors are influenced by external factors such as conflict and disasters related to displacement.

These interlinked factors require a multisectoral and multidisciplinary response, including conflict resolution, to building state capacity. Local and international stakeholders should support rebuilding the health system, especially primary care services and prioritising EPI. This should include sufficient, competent, and well-communicating health workers. Further, to develop specific strategies like outreach and community-based initiatives to reach communities in slums, rural and nomadic areas.

7.2. Recommendations

The literature review findings conducted and analyzed lead to the following short and long-term multi-sectoral approaches to increase immunization coverage in the Puntland state of Somalia. The following critical intervention on both supply and demand sides should be considered from program management, stakeholder, and policy perspectives.

- Scaling up, implementing, and monitoring available immunization strategies and plans to improve immunization coverage. The current immunization delivery and demand creation strategies should be reviewed to increase immunization coverage.
- To strengthen the capacity and skills of the district and regional management teams to lead better and manage immunization services delivery.
- Supply chain management and vaccine availability are essential to increasing immunization coverage and ensuring equity. Therefore, Financial commitments and strengthening sustainable partnerships with stakeholders like GAVI, WHO and UNICEF should be prioritized to improve the supply chain management system.
- Health management information systems (HMIS) at all levels should be strengthened to enhance monitoring and inform future programs.

- A multisectoral approach involving health, nutrition, and livelihood partners to address socioeconomic inequality and ultimately improve immunization coverage needs to be established.
- As the government has a limited capacity to expand immunization services, contracting out health services to NGOs will be a successful strategy that can rapidly expand immunization services. A critical stakeholder analysis will be vital.
- As the health service utilization is low in Puntland state, a cost-effective intervention such as community-based health initiatives should be established and implemented, including home visits by trained community health workers to promote access to maternal and child health. They can gauge the sentiments and attitudes of people, and they may help convince people about the importance of vaccinations. This also addresses the inequality in access to health services in rural and urban areas.
- Vaccine campaigns and outreach programs, including mobile health services, Child Health Day and SAIs, should be critically designed and implemented to target those displaced by drought and conflict, rural and nomadic populations in hard-to-reach by mopping to identify their locations: this address geographical inequities and other factors linked to low vaccination rates.
- Demand creation strategies through awareness and education at the health facility and community level. As Somali people are an oral society, face-to-face communication encourages people to ask about immunization and enhances their knowledge, improving access to immunization services. Working with established community structures, traditional birth attendants, and religious leaders should be initiated using face-to-face communication to gain trust and dispel all misconceptions about a vaccine.

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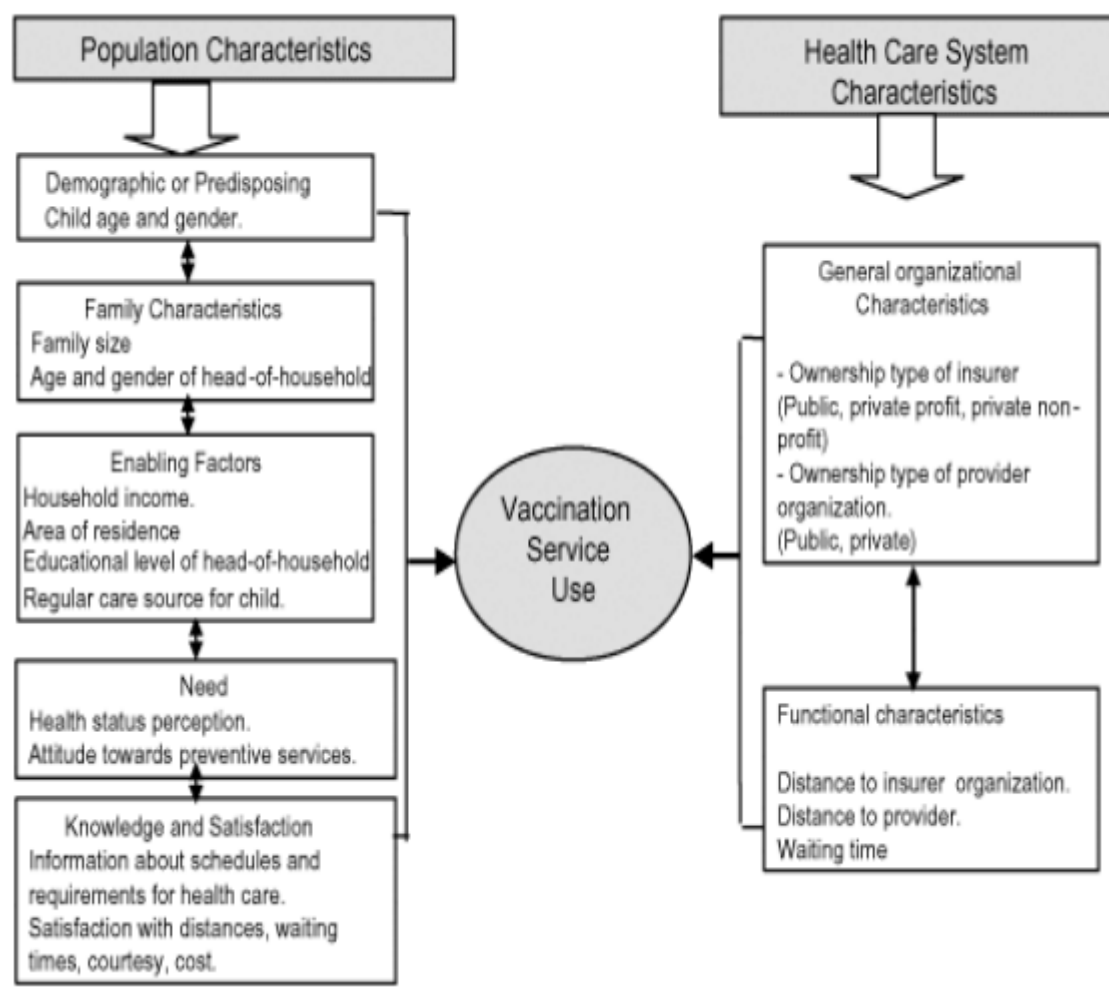
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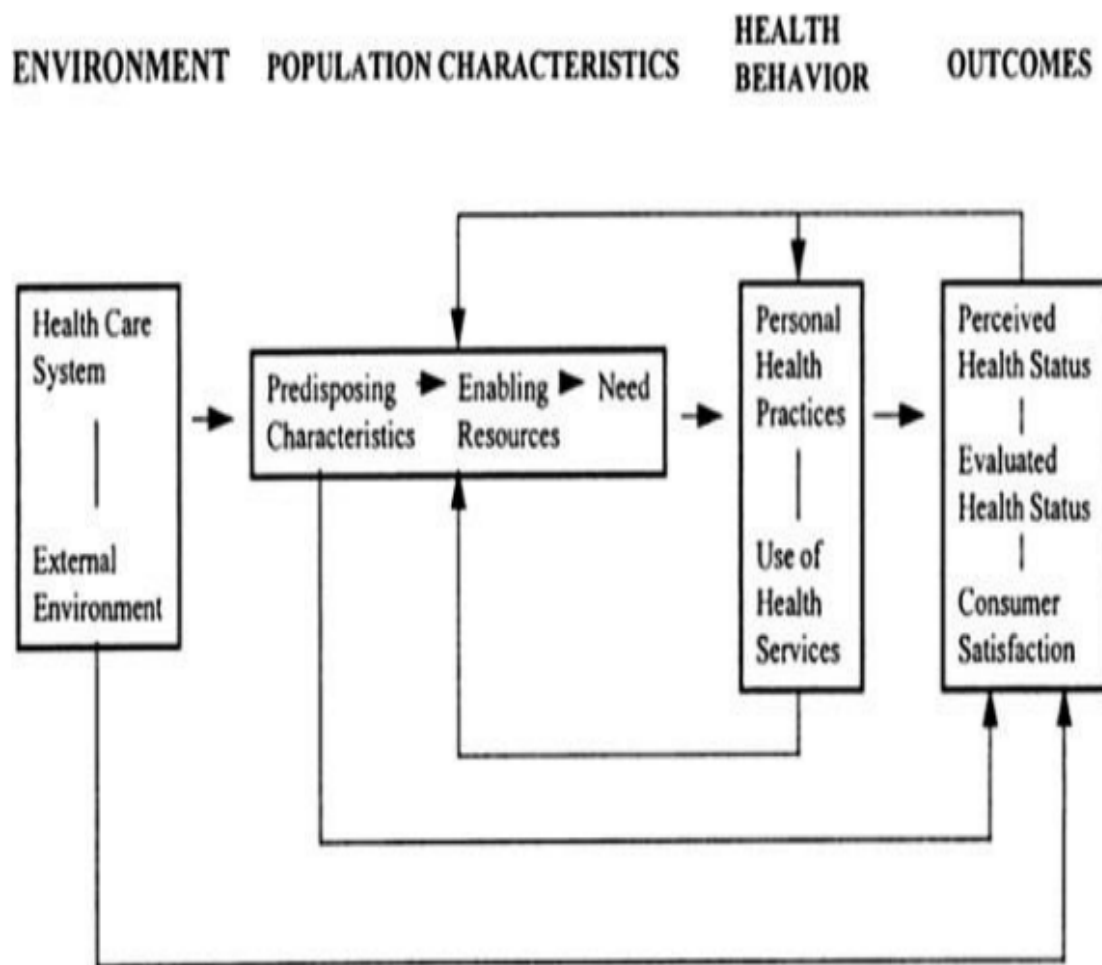
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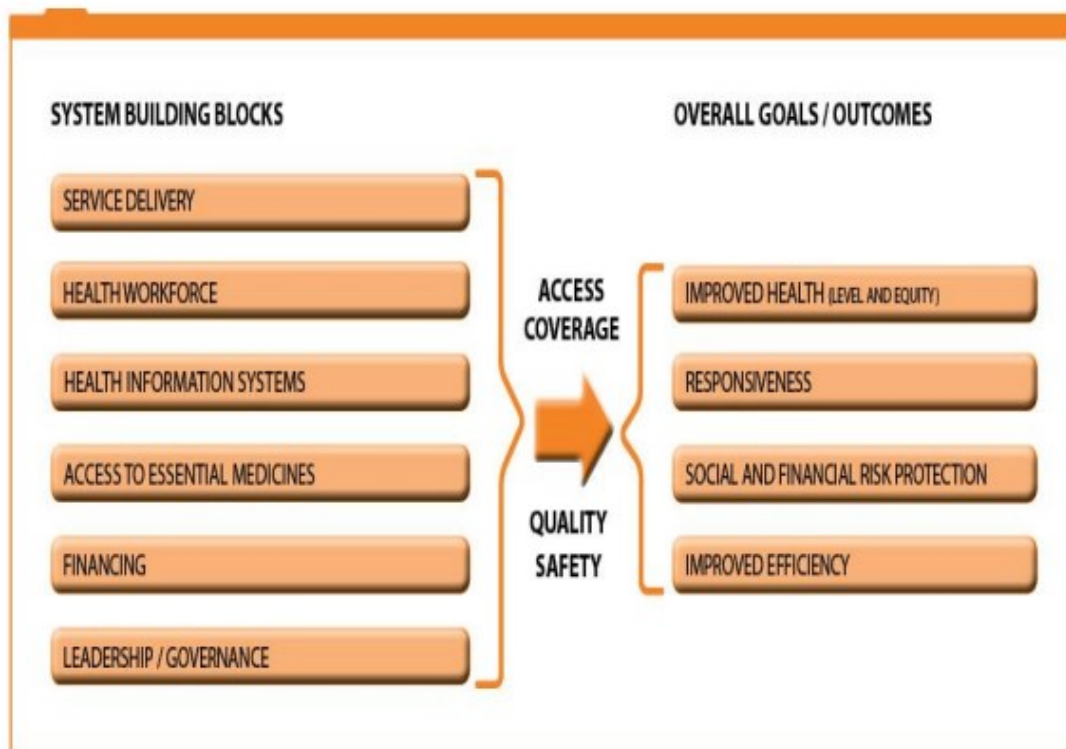
9. Appendices



Appendix 1 The conceptual and analytical framework adopted for this study was based on Andersen's Behavioral Model of Health Services Utilization (41)



Appendix 2: Andersen's Behavioral Model of Health Services Utilization (42)



World Health Organization (WHO) proposed a framework describing health sys terms in terms of six core components (43)