Analyzing the Stakes and Barriers to Effective Uptake of Expanded Programme on Immunization in Rural Cameroon: The Case of Benakuma Health District

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DOI: https://doi.org/10.51244/IJRSI.2025.1215000166P

Received: 01 September 2025; Accepted: 06 September 2025; Published: 31 October 2025

ABSTRACT

Immunization coverage remains a critical global health challenge, particularly in remote and conflict-affected regions. Benakuma, a remote health district in Cameroon's North West Region, faces significant challenges in immunization services. With a target population of 9,079 children for vaccination, coverage remains insufficient. This persistent low uptake, coupled with high dropout rates, has contributed to recurrent vaccine-preventable disease epidemics. This study evaluated the current operational stakes of immunization services and determinants of the critically low vaccination uptake in the Benakuma Health District. A cross-sectional mixed-methods study was conducted, integrating both qualitative and quantitative approaches. A situational analysis was performed through in-depth interviews, Focus Group Discussions (FGD), document reviews and the administration of 385 questionnaires across three functional health areas using a simple random sampling technique. Data were analyzed using descriptive and inferential statistics (Chi-square ($\chi 2$)) test, to determine associations between factors and EPI uptake at a significance level of $p<0.05$ and results were presented using tables and figures. Enrolment data revealed extreme volatility and a catastrophic failure to meet the Cameroon national EPI target of 85% to 90%. Coverage peaked at 71.40% in 2017 before collapsing sharply by −36.30 percentage points in 2019 to 34.70%. The lowest point was in 2020 at 18.00%, leaving 82.00% of the population not enrolled. While recovery efforts were observed through 2024 (reaching 52.00%), the rate remains approximately 33 to 42 percentage points below the required national goal. The study identified significant barriers associated with low EPI uptake, falling into three main categories: health system/supply-side deficiencies (waiting time), contextual factors (insecurity and remoteness), and caregiver/demand-side challenges (lack of awareness, personnel and hesitancy). The Benakuma Health District is in a profound public health crisis, characterized by a severe collapse in immunization coverage directly impeding the achievement of national EPI targets. A multi-faceted approach is therefore necessary to effectively address these challenges through improve access to vaccine and mobile clinics including a performance-based incentives, targeted campaign, trust, increase capacity and vaccine supply chain management.

Keywords: Measles, mortality, accessibility challenges, immunization services, resilient, Benakuma, Cameroon

INTRODUCTION

Vaccines are often described as “victims of their own success” (Iwasaki & Omer, 2020; Nadeem, 2018). They are so effective at preventing disease, few people remember the devastation and suffering those diseases such as measles and polio can cause... This breeds complacency as many people do not prioritize vaccination while others view potential vaccine side effects as a more concerning issue than the disease itself (As cited in: The

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV October 2025 | Special Issue on Public Health

Paradox of Vaccine Preventable Diseases, McIntosh et al., 2016; Public Health Insight, 2021). Experts identified refusal or reluctance to vaccinate despite vaccines availability as one of the top ten (10) worldwide health threats in 2019 (Raimi et al., 2021; WHO, 2021; 2024). The WHO defines vaccine hesitancy as the reluctance or refusal to vaccinate despite the availability of vaccines (WHO, 2021).

Vaccination is a major, but simple and cost effective public health intervention in the prevention of infectious diseases, especially in children (Mihigo *et al.,* 2015) reducing morbidity and mortality (Mackroth *et al.,* 2010). Immunization is recognized as the cornerstone of global public health and a vital component of primary care, representing a crucial investment in the future (WHO, 2024). By preventing infectious diseases, vaccines significantly alleviate poverty, increase productivity, improved educational attainment and promote greater lifelong contributions to national development and economic prosperity. It is therefore the role of all working in public health to remain vigilant regarding vaccine preventable diseases and challenges (Public Health Insight, 2021). Given its broad reach and impact, vaccination is arguably the most far-reaching health intervention globally. In recognition of the benefits of immunization, there has been a need to extend its coverage worldwide, especially in low income countries with the highest child and maternal mortality rates (WHO, 2020). Since its launching in 1974 (WHO, 1998), vaccination has contributed tremendously in reducing morbidity and mortality worldwide (IGME, 2013). Also, between 2010 and 2017, the mortality rate of children less than 5 years of age decreased by 24%, due to immunization (Global Burden of Disease, 2017). Recent studies opined that vaccines will help keep an estimated 24 million people from falling into poverty by 2030 (Chang *et al.,* 2018).

However, the clear medical consensus on vaccine benefits is increasingly challenged by individuals who erroneously view immunization as both dangerous and unnecessary (Raimi *et al.,* 2021). Vaccine preventable diseases continue to be a serious public health problem (Wolfson *et al.,* 2008) making immunization a veritable child survival strategy necessary to maintain and improve vaccination coverage addressing challenges like funding, shortage, culture and misinformation (WHO, 2025). In 2024 alone, 89% of infant globally about 115 million received at least one dose of diphtheria, tetanus and pertussis (DTP) containing vaccine and 85% roughly 109 million completed all three doses according to the new national immunization coverage data prevents more than 2.5 million child deaths (WHO, 2024).

In developed countries, the immunization situation is generally better, with much lower mortality rate due to improved funding and health infrastructure. For instance, high income countries have maintained at least 90% vaccination coverage reducing the number of un and under vaccinated children by roughly 650,000. Despite this success, millions of children remains without protection against vaccine preventable diseases and that should worry us all. Approximately, 10 million under five deaths occur in low-income countries annually especially in Africa (Rutherford *et al.,* 2009; WHO, 2024). Immunization is therefore a key intervention strategy geared towards attaining Sustainable Development Goals 3 (SDGs) on ensuring good health and wellbeing for all age group through reducing maternal and child mortality, ending pandemics, achieving universal healthcare coverage (Kagina, 2025; Public Health Insight, 2021). According to WHO (2022), the global under-five mortality rate declined to 37 deaths per 1000 live births in 2020, down from 93 deaths per 1000 live births in 1990. The goal is to reduce it to at least 25 deaths per 1000 live births by 2030. Vaccinations have therefore indeed played a crucial role in this decline.

Despite the documented benefits of vaccination in reducing child mortality, regional disparities in access remain a crucial problem (Kagina, 2025). Sub-Saharan Africa (SSA) continue to be one of the world's highest risk of neonatal deaths sharing 40% of the under-five death globally due to health disparities, increasing inequalities and other challenges (Acharya et al., 2018). For instance, while successes such as smallpox eradication should rightfully be celebrated, WHO (2022) noted that SSA still face significant challenges, with an under-5 mortality rate of 74 deaths per 1000 live births in 2020, highlighting the need for continued efforts in vaccination and healthcare delivery. According to UNICEF report, 12.7 million children in Africa alone have missed one or more vaccine doses in three years, with 8.7 million of them not having received a single dose (Kagina, 2025).

The key spatial drivers of immunization justices and coverage across populations include, socioeconomic conditions, healthcare infrastructure, cultural beliefs, COVID 19 disruption of the health services, conflict and

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV October 2025 | Special Issue on Public Health

the impact of climate change misinformation, disruption to routine care, low educational level of parents/caretakers, cultural/religious beliefs, age of caretakers, terrain, accessibility to health facilities, refugee status, mobility of populations, negative messaging/anti-vaccine sentiments and socio economic status and attitudes of the parents/caretakers (Raimi *et al.*, 2021; Public Health Insight, 2021). For instance, Polio was all but eradicated in the early 2000s, but vaccine misinformation, crisis due to safety concerns in Nigeria regarding the oral polio vaccine brought wide-spread boycotts. Polio cases sharply increased not only in Nigeria, but also spread to previously polio-free neighbours (Parker, 2020). Nigeria and Ethiopia remains the only two countries with the highest number of children who do not receive the basic routine vaccinations every year with more than 2.2 million and 1.1 million children respectively (Kagina, 2025).

The EPI was introduced in Cameroon in 1976 as a pilot project coordinated by the organization called the control of Endemic Diseases in Central Africa (OCEAC). This project became operational in 1982 and all the regions were incorporated into the Minimum Package of Activities (MPAs) of all health facilities in the country (Comprehensive Multiyear plan for EPI Cameroon, 2011). One of the important factors which affected the parental practice is their knowledge regarding vaccination (Andre *et al.,* 2008). Moreover since 2010, the national target has been to achieve national immunization coverage of 90% with 80% at the health area level and health districts respectively (Comprehensive Multiyear Plan for EPI Cameroon, 2011). To achieve these objectives, several vaccination strategies were adopted and recommended to be used in health facilities. These strategies include organizing vaccination at fixed posts, outreach vaccinations, mobile and supplementary vaccination activities (Ministry of Health, 2009). Endorsed by the World Health Assembly in 2012, the Global Vaccine Action Plan 2011–2020 (GVAP) calls on all countries to reach ≥ 90% coverage with all vaccines in the country's national immunization schedule by 2020 (Frew & Lutz 2017).

Unfortunately, the EPI in Cameroon continue to face significant challenges in terms of coverage rate, inadequate programme management, and financial constraints. In the Benakuma Health District, these issues may be exacerbated by factors such as limited healthcare access, cultural barriers and the Anglophone crisis. The district's vaccination coverage rate is likely to below the national average, comprising head immunity and leaving the population vulnerable to vaccine-preventable diseases. While existing studies on immunization (Amani *et al.,* 2023) highlighted general issues with vaccination coverage and programme management in Cameroon, this study focuses on a localized research to inform evidence based interventions and improved on the effectiveness of EPI. This will ultimately contribute to the development of targeted strategies to enhance vaccination coverall and protect the health of the population for sustainable development. This study therefore assesses the stakes and barriers to effective update of the EPI in Benakuma Health District, with a focus on identifying context specific challenges and developing targeted interventions to improve vaccination coverage and address the barriers thus contributing to public health by protecting the population from vaccine-preventable diseases.

Conceptual Framework Of Immunization Agenda 2030 (Ia2030)

The WHO IA2030 which set an ambitious overarching global vision and strategy for vaccines and immunization for the decade 2021-2030 was used for this study. It draws on lessons learnt, acknowledges continuing and new challenges posed by infectious diseases and capitalizes on new opportunities to meet those challenges. IA2030 positions immunization as a key contributor to people's fundamental right to the enjoyment of the highest attainable physical and mental health and also as an investment in the future, creating a healthier, safer, more prosperous world for all. IA2030 aims to maintain and build on immunization gains, maximize the lifesaving impact of vaccines, reduce vaccine-preventable diseases, and strengthen primary healthcare systems to support universal health coverage.

It is a flexible, country-led strategy, developed through a collaborative process, intended to inspire and align the activities of community, national, regional and global stakeholders, including national governments, regional bodies, global agencies, development partners, healthcare professionals, academic and research institutions, vaccine developers and manufacturers, the private sector and civil society around shared vision for immunization. It is designed to inspire action around the world, and inform how health ministers and other leaders develop immunization programmes and set priorities. It also strengthens global immunization efforts by aligning all stakeholders around a shared vision, priorities, and goals. Its impact will help maximized

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV October 2025 | Special Issue on Public Health

effective and efficient use of resources, innovation and measures to attain financial and programmatic sustainability. This will save 50 million lives over the next decade.

The success of IA2030 implementation depends on partnerships as part of a coordinated effort to improve access to high-quality, affordable primary health care, achieve universal health coverage and accelerate progress towards the 2030 SDGs. IA2030 is therefore guided by four principles: people in the centre, and is led by countries, implemented through broad partnerships, and driven by high-quality data (Figure 1). As an adaptive and flexible strategy, IA2030 countries will be able to meet their needs, and revised as new opportunities and challenges emerge.

Figure 1: Conceptual framework of Immunization Agenda 2030 (IA2030)

Source: Adapted from WHO, 2021

As seen on Figure 1, unlike many global strategies, IA2030 was developed through a collaborative "bottom up" co-creation process that engaged thousands of stakeholders around the world. This approach has helped ensure it reflects the real needs of countries that face the greatest health inequalities. It also draws on lessons learned from implementation of the Global Vaccine Action Plan (2011-2020) and disease-specific initiatives such as polio and measles eradication efforts.

Thus, IA2030 has seven strategic priority areas. A strong linkages between PHC services and immunization programmes, particularly for reaching the target population for vaccines especially the poorest, marginalized, and most vulnerable with little or no access to immunization services. Currently, close to 20 million infants do not receive a full dose of even basic vaccines, and many more miss out on newer vaccines. Of these, over 14 million "zero dose" children receive no vaccines through immunization programmes at all. Other IA2030 strategic priority areas stress the importance of PHC: commitment and demand (SP2), coverage and equity (SP3), life course and integration (SP4), outbreaks and emergencies (SP5), supply and sustainability (SP6), research and innovation (SP7).

Vaccines are critical to the prevention and control of many communicable diseases, which is an essential part of global health security. In some countries like Cameroon, progress in immunization has stalled, or even reversed, and there is a risk of undermining past immunization achievements. Outbreaks of measles, diphtheria and polio are stark reminders that strong immunization programmes and effective disease surveillance are necessary to sustain high levels of immunization coverage, and to eliminate and eradicate diseases. The targets to be achieved over immunization by 2030 included a 90% coverage for essential vaccines given in childhood and adolescence, halving the number of children completely missing out on vaccines and completing 500 national or subnational introductions of new or under-utilized vaccines (COVID-19, rotavirus, or human papillomavirus (HPV)).

Although, this framework was used to ensure the global relevance of this study, unwillingness and resistance to uptake of vaccination is a substantial issue in Benakuma Health District, particularly during the outbreak of diseases which was immediately followed by the sociopolitical crisis. Vaccinations become one of the most

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV October 2025 | Special Issue on Public Health

imperative public health tools for reducing the spread and harm caused by dangerous diseases (Raimi et al., 2020). Despite the global efforts in achieving vaccination especially during COVID 19 pandemic, there is increasing skepticism toward vaccination in Cameroon. Several barriers have led to a decline in vaccine uptake and to an increase in the prevalence of Vaccine-Preventable Diseases (VPDs). Ironically, the objection to vaccines is commonly attributed to their effectiveness, because individuals have little to no exposure to VPDs, they are less concerned about contracting them, which consequently leads to greater vaccine hesitancy. The experience in the study area indicated that parents are not willing to take vaccine due to cultural barriers, socioeconomic, and geographical factors. Particularly due to misinformation, parents think they want to sterilize the population. Hence, continuous health education and effective communication and community engagement could help in the promotion of EPI. IA2030 also noted collaborative, country-owned partnership approach to immunization and a monitoring and evaluation framework to guide and enhance country implementation.

REREARCH METHODOLOGY

Settings and Research Design

This study was carried out in the Benakuma Health District, one of the enclaved/remote Districts among the 19 Health Districts located in the Menchum Division of the restive North West Region of Cameroon. Geographically, the sub division is located between Latitude 6°24'.99 to 6°31' North of the Equator and Longitude 9°54'.99 East to 10°20' East of Greenwich Meridian. As of 2023, the population of the Sub Division stood at 60,794 growing at a rate of 3% annual growth rate covering a surface area of 1,050 square kilometer. This represented approximately 20% of the Menchum Division (BUCREP, 2023). The EPI vaccination target was estimated at 9079 children. However, this has decreased significantly with consistently low vaccination coverage which stood at 52.00% as of 2024 and high dropout rate associated with repeated occurrence epidemics of Vaccine Preventable Diseases (VPD) like measles which killed 9 children during the 2015 measles outbreak in the district.

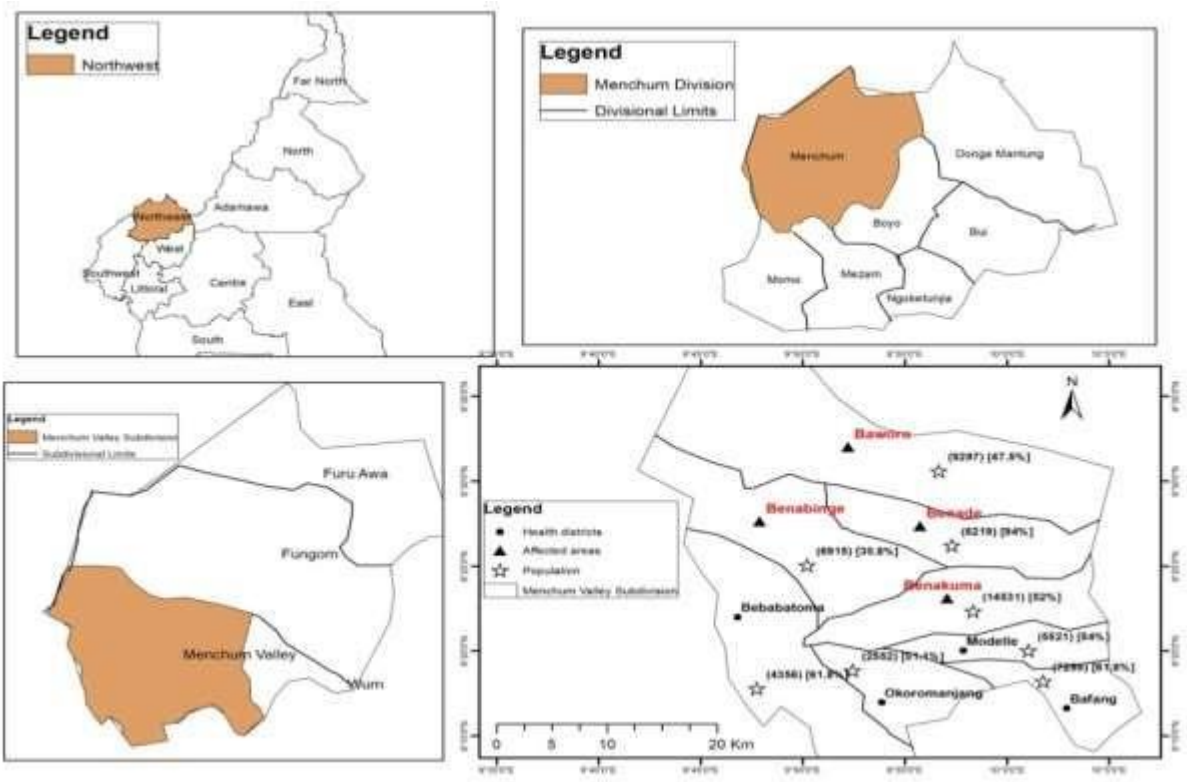

Figure 2: Sampled Health district showing outbreaks affected, population and vaccination statuses in Benakuma, Menchum Division, North West Region of Cameroon

Source: Adapted from the Administrative Map of Cameroon, 2016

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV October 2025 | Special Issue on Public Health

The geography consists of mix savanna and mountainous region contributing to ecological richness with features like rivers, mountains. The region receives an average annual rainfall of about 1344mm with October being the wettest month at 178mm. The rainy season usually peaks from July to September. The average temperature ranges between 24^{o}C to 31^{o}C with February being the hottest month at 26^{o}C and July being the coolest at 23^{o}C. The district is large with highly diversified cultures whose main occupation is agriculture due to the geographies, fertile soil and climate the cultivation of corn, cocoa, coffee, palm oil, granut and cassava with pastoral farming of cattle and sheep rearing. There are hand full of Nursery, Primary and Secondary schools with no professional school in the district. The district comprises 8 health areas with 12 health facilities, including 2 confessional health facilities and 10 public health facilities sharing. It is bordered with Wum, Bafut, Njikwa and Akwaya health districts and neighboring Nigeria (Figure 1).

This was a cross-sectional mixed methods study, which utilized both qualitative and quantitative approaches. A situational analysis of the immunization services was carried out using FGD (Table 1) with health personnel and caretakers with records review. This study was carried out both in both the community and the health facilities in the Benakuma Health District within a period of seven months where activities were carried out from November 2023 to May 2024.

Participants and sampling

The target study population included parents whose children are both enrolled and or non-enrolled of 18 years and above in some selected health areas and health facilities and some health personnel working in the Benakuma health district. Precisely parents/health personnel living and or working in the selected health areas who were ≥ 18 years of age, who gave their full consent to participate in the study were included in the study. Guardians in a particular household who could not give detailed information on the enrolment of household members (children 0-59 months) on EPI vaccination or who were sick on the day of the study were excluded.

Data collection and variables

Sample questionnaire was administered to parents (women) with children coming for vaccination in the various health facilities within the District. The dependent variable was non-enrolment into EPI activities and the independent variables includes gender, age group of participants (years), age of children (months), marital status, level of education, occupation, religion and distance from vaccination center (km). A simple random sampling method was used to select 3 health facilities with the exception of 2 non-functional facilities such as Baworo and Mukuru health facilities due to political unrest. The three health facilities selected included Benade, Benabinge and Benakuma Urban IHCs. A convenient sampling technique was used to get the parents and personnel (participants) that were used for the study by selecting from records of the selected health facilities.

Table 1: Question guide for FGD

No	Focus Group Discussion Questions
1	What is vaccination and why is it important?
2	Do you think that all parents from your area take their children to register for vaccination? Are there those who do not? What are some of the reasons why they opt not to take the children for vaccination?
3	Are there any associations, religious groups or cultural groups that encourage/discourage parents from registering and vaccinating their children? If yes, what are their reasons for supporting or being against vaccines/vaccination?
4	Are there periods/situations when you failed to take your child for vaccination? What were/are the reasons?

5	What do you think can be done to help parents/caregivers to demand and have more access to vaccination services?
6	What do you think can be done to empower health care personnel from your locality to better provide sustainable vaccination services to the community?

Source: Fieldwork, 2025

The FGD was made up of 9 participants (8–12) (Table 1), with a moderator and note taker and recording of the proceedings was done with an audio/visual tape. Each participant provided informed consent to participate in the FGD and recording.

Data Management and statistical analysis

Qualitative findings from FGD (audio recordings) and note taken were transcribed into Microsoft Word 2010 by the researcher and the assistants. After transcription, team members compared each audio tape to its respective transcript and notes taken for accuracy. For records reviewed, data were obtained from the vaccination registers for the last five years and entered in to a Microsoft Excel spread sheet. The transcribed data was then imported into the SPSS and/or Excel program explored, analyzed and findings obtained. For quantitative data processing, a template was prepared using Epi-Info version 7.2.2.6 and the data entered. The data was later exported into Microsoft Excel version 2024 where cleaning was done and later exported SPSS version 25.0 where it was categorized and coded for further analysis. Frequency and proportion were computed for descriptive studies and other significant variables. Both bivariate and multivariate logistic regressions were computed to see the association of each category of each variable with the outcome variable. Significance was set at 95% CI. Variables with $p<0.05$ in binary logistics regression were analyzed through multivariate logistics regression to control potential confounders. Statistical significance was disclosed at $p<0.05$ at 95% CI to identify the determinant of non-enrolment into EPI and the results were presented using tables and figures.

Participant consent and ethical approval

Ethical approval was obtained from the Ethics Committee of the University of Buea (FHS-IRB) (Approval number: 1142-02 of 24th March 2023). Administrative authorization was obtained from the Regional Delegation of Public Health for the North West Region and from the Benakuma Health District service. The study involved two different aspects of consent. Separate individual written informed consent was obtained for each parent/caretaker to answer the questionnaire and for each participant included in the FGD. Confidentiality was maintained using ID codes where indicated. Names of participants were not recorded, in addition verbal consent was obtained from all those involved in the study. Consent forms and questions were available in English language. There was no major risk in participating in this study despite the crisis. The purpose of the study and procedures were explained to all participants in the local language (pidgin) at the time of recruitment. All participants were treated equally and fairly.

RESULTS

Sociodemographic characteristics

Sociodemographic factors revealed that a total of 385 parents of children aged between 0–59 months participated in the study. The highest proportion (41.1%) of respondents were aged between 21 and 30 years. The majority (77.5%) of the participants were females. Most of the parents' children (46.8%) were aged between 6–12 months. Most of the parents were married (66.1%), and about two-thirds (65.6%) were first school leavers (primary education completed). A good number of participants (76.5%) had farming as their main occupation, and 37.7% were Catholic by faith. A significant portion of the parents (61.8%) resided more than 5 km from health facilities.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV October 2025 | Special Issue on Public Health

The relationship between distance to health facilities and various factors showed no statistically significant

relationship with non-enrolment in EPI activities: age group to vaccination site ($\chi2=0.822$,P=0.844), gender ($\chi2=0.101$,P=0.750), age of children ($\chi2=0.690$,P=0.876), marital status ($\chi2=599$,P=0.273), level of education ($\chi2=2.493$,P=0.477), and occupation ($\chi2=4.104$,P=0.250). However, the association between distance to health facilities and religious belief ($\chi2=7.809$,P=0.041) was statistically significant and related to non-enrolment in the EPI activities within the Health District.

Stakes of Vaccination and Immunization

This section explores the nature, trends and the associated socioeconomic determinants of enrollment into EPI activities in the Benakuma Health District.

Nature and Trends of Vaccination

Cameroon's national EPI, like most worldwide, aims for and strives to maintain immunization coverage of at least 85% to 90% for core childhood vaccines (DTP3) to achieve adequate public health protection. For highly transmissible diseases like measles, the required threshold for herd immunity is even higher, typically 95%. Unfortunately, results from the study revealed a high proportion (91.5%) of the participants were not enrolled leaving the vast majority of individuals vulnerable to vaccine-preventable diseases while only 8.5% were enrolled in the EPI activities. This extremely low coverage rate is nowhere near the required threshold to establish herd immunity, which is necessary to protect the entire community, including those who cannot be vaccinated (infants too young for certain doses, or immune-compromised individuals). The 8.5% enrollment rate in Benakuma contrasts starkly with Cameroon's national public health and international goals for immunization. Cameroon's national health policy, aimed at controlling vaccine-preventable diseases. This policy historically targeted and projected reaching and maintaining a minimum national coverage of at least 90% for eligible children. Earlier goals included targets of 80% coverage, which were generally maintained, but current goals are aligned with global standards. For highly contagious diseases like measles, the WHO, which guides national EPIs in Cameroon, specifies routine vaccination coverage of at least 95% with two doses is the key intervention to achieve elimination and establish sufficient herd immunity. Based on the respondents' views, the district's coverage is approximately 81.5 to 86.5 percentage points below the desired 90% to 95% threshold. This low rate puts the district and surrounding areas at imminent risk of large-scale outbreaks of future pandemics, and contributing to the national problems of children missing essential vaccines.

From every Health District within Cameroon with the highest enrolment rate recorded in 2017 (71.4%), these has dropped drastically with the lowest rate registered in 2019 and 2020 (22.6%). This is indeed a serious call for concern for health actors especially in Benakuma. Table 2 presented the last nine years' enrolment rate which is far lower than expected (85-90%) national standards.

Table 2: Enrolment rate for EPIs in the Benakuma Health District (2015-2020)

Year	Enrolled (%)	Change in Enrolled (pp)	Not Enrolled (%)	Change in Not Enrolled (pp)
2016	45.30	N/A	54.70	N/A
2017	71.40	+26.10	28.60	-26.1
2018	71.00	-0.4	29.00	+0.40
2019	34.70	-36.3	65.30	+36.30
2020	18.00	-16.7	82.00	+16.70

2021	25.50	+7.50	74.50	-7.5
2022	35.00	+9.50	65.00	-9.5
2023	42.00	+7.00	58.00	-7
2024	48.00	+6.00	52.00	-6

Source: Fieldwork, 2025

Table 2 shows that, between 2017 and 2018, there were high peak of enrollment into EPI (71.00% to 71.40%) show the health district was capable of achieving high coverage, though still 13.6 to 19.0 pp below the 85% to 90% national target. The majority of the populations were enrolled, limiting the risk of major outbreaks. The percentage change of enrollment between 2016 and 2017 was (+26.10 pp) followed by stability in 2018, indicating a successful initial campaign or stabilization phase. Between 2019 and 2020, there was a systematic collapse in enrollment for vaccination as revealed by (18.00% to 34.70%). The rate collapsed in 2019 and hit a trough of 18.00% in 2020. The 18.00% rate is 67.0 to 72.0 pp below the national target. The Not Enrolled population surged to 82.00% in 2020. The massive drop 36.30 pp in 2019 and −16.70 pp in 2020 results from the Anglophone Crisis and early COVID-19 pandemic effects, which severely limit access and security for service delivery. An enrollment of (25.50% to 48.00%) showed a consistent, but slow, recovery. By 2024, the 48.00% enrolment rate is still less than half the national target (a deficit of 37.0 to 42.0 pp). The Not Enrolled population remains high at 52.00%.The trends in the Benakuma Health District revealed a public health system that was highly functional in 2017-2018 but was subsequently devastated by crisis, leading to a near-total collapse of the immunization program in 2020. The ongoing recovery was too slow to meet the national health goal of protecting citizens, creating a long-term risk.

Socio-demographic Determinants of Enrolment into the EPI program

As shown in Table 3, most participants aged between 31 and 40 years had similar odds of failing to enroll their children into the EPI program compared to those aged below 21 years (OR=1.41, 95% CI:0.36−5.49, p=0.624). Male-headed households had 36% lower odds of enrolment into the EPI program compared to female parents, though this was not statistically significant (OR=0.64, 95% CI:0.29−1.40, p=0.263). The odds of having a child aged 13–24 months enrolled in the EPI program were 1.09 times higher as compared to children less than 6 months old (OR=1.09, 95% CI:0.32−3.76, p=0.885). Parents or caregivers who were divorced were 4.34 times more likely to have failed to enroll their children into EPI activities compared to parents who were married, though this was not statistically significant (OR=4.34, 95% CI:0.57−33.00, p=0.156). Parents with primary education were significantly more likely to fail to enroll their children in EPI compared to those with tertiary education (OR=14.88, 95% CI:4.31−51.38, p=0.000), confirming that this educational difference is a statistically significant determinant. Farmers had 45% lower odds of enrolment into EPI compared to students, though this was not statistically significant (OR=0.55, 95% CI:0.07−4.23, p=0.562). Being a Muslim was associated with 45% lower odds of non-enrolment compared to being a Christian (OR=0.55, 95% CI:0.11−2.84, P=0.475), a finding that was not statistically significant. Crucially, the odds of participants living more than 5 km from the health facilities remained 2.07 times higher than those living within 5 km from the health facilities (OR=2.07, 95% CI:0.01−4.24, p=0.048), indicating that distance is a statistically significant factor for non-enrolment.

Table 4 shows that the odds of parents with no feelings upon a child's vaccination were 3.34 times higher to have failed to enroll their children into the EPI compared to those that were happy, though this was not statistically significant (OR=3.34, 95% CI:0.44−25.29, p=0.242). The odds of participants whose belief about vaccination was discouraging were 3.05 times higher of failing to enroll their children into EPI as compared to those who had good belief about vaccination, a finding that was statistically significant (OR=3.05, 95% CI:1.05−8.90, p=0.041).Parents/caregivers whose religion did not accept vaccination were 83% less likely to enroll their children (or 5.88 times more likely to fail to enroll) compared to the reference group, though this was not statistically significant (OR=0.17, 95% CI:0.18−3.75, p=0.809).

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV October 2025 | Special Issue on Public Health

Table 3: Socio-demographic factors associated with non-enrolment into the EPI program

Characteristic	**EPI enrolment status**					
	Enrolled No (%)	**Not enrolled No (%)**	**Total No (%)**	**OR**	**95% CI**	**p-value**
Age group (years)						
<21	3(8.6)	32(91.4)	35(100)	1.00	-	-
21-30	16(10.1)	143(89.9)	159(100)	0.84	0.23-3.05	0.788
31-40	9(6.3)	135(93.8)	144(100)	1.41	0.36-5.49	0.624
>40	5(10.2)	44(89.8)	49(100)	0.83	0.18-3.71	0.802
Total	**33(8.5)**	**354(91.5)**	**387(100)**			
Gender						
Female	23(7.7)	277(92.3)	300(100)	1.00	-	-
Male	10(11.5)	77(88.5)	87(100)	0.64	0.29-1.40	0.264
Total	**33(8.5)**	**354(91.5)**	**387(100)**			
Age of children (in months)						
<6	4(8.9)	41(91.1)	45(100)	1.00	-	-
6-12	15(8.3)	166(91.7)	181(100)	1.08	0.34-3.43	0.896
13-24	9(8.2)	101(91.8)	110(100)	1.09	0.32-3.76	0.885
>24	5(9.8)	46(90.2)	51(100)	0.90	0.23-3.57	0.878
Total	**33(8.5)**	**354(91.5)**	**387(100)**			
Marital status						
Married	23(9.0)	233(91.0)	256(100)	1.00	-	-
Single	9(10.5)	77(89.5)	45(100)	0.85	0.38-1.90	0.684
Divorced	1(2.2)	44(97.8)	45(100)	4.34	0.57-33.00	0.156
Total	**33(8.5)**	**354(91.5)**	**387(100)**			
Level of education						
None	4(9.5)	38(90.50	42(100)	9.50	2.06-43.89	0.004
Primary	16(6.3)	238(93.7)	254(100)	14.88	4.31-51.38	0.000

Secondary	7(8.9)	72(91.1)	79(100)	10.29	2.61-40.56	0.001
Tertiary	6(50.0)	6(50.0)	12(100)	1.00	-	-
Total	**33(8.5)**	**354(91.5)**	**387(100)**			
Occupation						
Farming	21(7.1)	275(92.9)	309(100)	0.55	0.07-4.23	0.562
Others	11(20.8)	42(79.2)	53(100)	0.16	0.92-1.31	0.087
Student	1(4.0)	24(96.0)	25(100)	1.00	-	-
Total	**33(8.5)**	**354(91.5)**	**387(100)**			
Religion						
Christian	10(9.1)	100(90.9)	256(100)	1.00	-	-
Islam	2(15.4)	11(84.6)	13(100)	0.55	0.11-2.84	0.475
Others	11(9.3)	107(90.7)	118(100)	0.97	0.40-2.84	0.973
Total	**33(8.5)**	**354(91.5)**	**387(100)**			
Distance from vaccination center (km)						
>5	15(6.3)	224(93.70	239(100)	2.07	1.01-4.24	0.048
< 5	18(12.2)	130(87.8)	148(100)	1.00	-	-
Total	**33(8.5)**	**354(91.5)**	**387(100)**			

Source: Fieldwork, 2025

Participants who claimed religious or cultural groups prevented them from enrolling for vaccination had a 2.24 times higher odds of failing to enroll children for vaccination as compared to those who did not claim this barrier. This finding was statistically significant (OR=2.24, 95% CI:1.05−4.76, p=0.036) (Table 4).

Table 4: The association between individual feelings with non-enrolment into EPI

	Characteristics	**EPI enrolment status**					
		Enrolled No (%)	**Not enrolled No (%)**	**Total No (%)**	**OR**	**95% CI**	**p-value**
The feeling of parents/caretaker upon child vaccination							
	Happy	31(2.9)	306(90.8)	337(100)	1.00	-	-
	Nothing	1(2.9)	33(97.1)	34(100)	3.34	0.44-25.29	0.242

	Sad	1(6.3)	15(93.8)	16(100)	1.52	0.19-11.90	0.690
	Total	**33(8.5)**	**354(91.5)**	**387(100)**			
Parents belief about children vaccination							
	Bad	0(0.0)	3(100.0)	3(100)	-	-	-
	Discouraging	4(3.7)	104(96.3)	108(100)	3.05	1.05-8.90	0.041
	Good	29(10.5)	247(89.5)	276(100)	1.00	-	-
	Total	**33(8.5)**	**354(91.5)**	**387(100)**			
Does the parent religion accept vaccination							
	No	2(10.0)	18(90.0)	20(100)	0.83	0.18-3.75	0.809
	Yes	31(8.4)	336(91.6)	367(100)	1.00	-	-
	Total	**33(8.5)**	**354(91.5)**	**387(100)**			
Participants who said religious association prevent them from vaccinating their children							
	No	22(11.6)	167(88.4)	189(100)	1.00	-	-
	Yes	11(5.6)	187(94.4)	198(100)	2.24	1.05-4.76	0.036
	Total	**33(8.5)**	**354(91.5)**	**387(100)**			

Source: Fieldwork, 2025

Uptake of EPI and Barriers to its Effectiveness

Based on the uptake of EPI, study results indicated that participants whose children had received poor treatment during vaccination were 2.00 times more likely not to have enrolled for subsequent vaccination (OR=2.00, 95% CI:0.59−6.77, p=0.265) as compared to those who had received good treatment during vaccination (Table 5). Health system barriers affecting enrolment into the EPI activities (Table 5) showed that participants who believed that the importance of vaccination was to treat diseases had 33% lower odds of enrolment (OR=0.67, 95% CI:0.11−4.23, p=0.667) as compared to those who correctly stated that it was important because it helps develop the children's defense mechanism, but this difference was not statistically significant. Similarly, parents/caregivers who did not understand the health talks during vaccination had 18% lower odds of enrolment (OR=0.82, 95% CI:0.27−2.47, p=0.725) as compared to those who had a good understanding of the health talks, even though this finding was statistically insignificant.

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ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV October 2025 | Special Issue on Public Health

Table 5: Health system barriers that affect enrolment into EPI

Characteristic	**EPI enrolment status**					
	Enrolled No (%)	**Not enrolled No (%)**	**Total No (%)**	**OR**	**95% CI**	**p-value**
Knowledge on the Importance of vaccination						
Defense mechanism	28(91.0)	280(90.9)	308(100)	1.00	-	-
Given for free	2(5.3)	36(94.7)	38(100)	0.56	0.13-2.43	0.435
Treat diseases	3(7.7)	36(92.3)	39(100)	0.67	0.11-4.23	0.667
Useless	0(0.00)	2(100.0)	2(100)	-	-	-
Total	**33(8.5)**	**354(91.5)**	**387(100)**			
Understand the health care talks during vaccination						
No	4(10.0)	36(90.0)	40(100)	0.82	0.27-2.47	0.725
Yes	29(8.4)	318(91.6)	347(100)	1.00	-	-
Total	**33(8.5)**	**354(91.5)**	**387(100)**			
What to do to help parents access more vaccination services						
Increased vaccination sites	6(3.0)	195(97.0)	201(100)	5.55	2.24-13.79	0.000
Those refusing vaccines should be punish	0(0.0)	1(100.0)	1(100)	-	-	-
Do more sensitization	27(14.6)	158(85.4)	185(100)	1.00	-	-
Total	**33(8.5)**	**354(91.5)**	**387(100)**		-	-

Source: Fieldwork, 2025

Participants who stated that parents needed an increment in vaccination centers to enable them access more vaccine services showed 5.55 times higher odds of having failed to enroll their children compared to those who needed more sensitizations (OR=5.55, 95% CI:2.24−13.79, p=0.000), indicating a highly statistically significant barrier (Table 5).

As revealed in the FGDs, a specific place of worship in the health district had been noted for refusing its members from taking part in vaccination activities. *"There was a church in Benakuma that refuses its worshippers from going to the hospital for whatever reason,"* stated a community member. As regards cultural associations towards vaccination activities in the District, two groups were cited as engaging in community activities that facilitated the enrolment of children in vaccination activities, as mentioned in the FGDs. These groups have empowered many community members to bring their children for vaccination, thus contributing to the surge in enrolled vaccinations: *''There are associations in Benakuma that help in encouraging vaccination, and since the hospital and the Health centers work hand in glove with SHUMAS, which is an NGO,"* reported a Health worker. *"There is a group in Benakuma known as the Beloved Sisters; they have been working tirelessly trying to find out all the loss-to-follow-up children for vaccination,"* reported another Health worker.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV October 2025 | Special Issue on Public Health

As regards the hindrances to enrolment into the vaccination program, the participants were unanimous that not every parent registers their children for the vaccination program, as indicated during the FGD. One participant noted: *"In my area, not all parents actually vaccinate their children,"* (Community member). Another stated: *"Not all parents do take their children for immunization or vaccination,"* (Health worker). Vis-à-vis reasons for non-enrolment of children for vaccination, the major problems revealed were in terms of distance (not able to cover the distance), lack of information, and misinformation (that vaccinating children is instead a cause of illness). There was also a general notion that vaccines can be harmful to the children (they believe it is a strategy that the government is using to kill or to sterilize their children).

Farming activities were also cited as a hindrance for most parents to enrolling their children for vaccination activities. One respondent noted: *"I take my child for vaccination but there are others who do not; they always say they have their farm work which they say is more important than vaccination, and during farming seasons, some migrate to their farmlands and stay there for months doing their farming,"* (Community member). Corroboratively, another respondent noted: *"I have always obeyed rendezvous for my children's vaccination sessions, but there are so many others, especially in Benakuma here, who do not obey because they think their farm work is more important than vaccination. They rather prefer to go and do their farming than bringing their children for vaccination even though they have been sensitized on the fact that vaccination is free,"* (Health worker).

Some of the reasons for non-enrolment of children into the vaccination programs included the periodic unavailability of vaccines in the health facilities. This has discouraged most parents from returning to the facilities for subsequent doses, as unveiled during the FGDs.

A community member noted: *"When we come and vaccines are not available, the health personnel ask us to come back on a different day, making us travel long distances, which is discouraging, especially during this crisis period."* The discomfort faced by parents after vaccinating their children was also cited as a barrier to routine vaccination. A health worker noted: *"Some parents complain that their children always have fever after vaccination, which makes them spend money on buying medications, while others complain that their children cry for some days after vaccination, disturbing the parents from their normal farm work*."

Parents' reliance on the use of traditional medicine, heavy rainfall at certain moments when the rivers are full, and long waiting times in the health facilities were reported as barriers to low enrolment into the vaccination activities. As revealed in the FGDs, listening to the parents, they envisage a situation where a health center could be constructed in their villages or stable outreach posts be created in these villages so as to reduce the distances that parents cover in risky situations in order to vaccinate their children. The health workers, on their own part, desire the provision of a cold chain and current, proper information which will enable the health facility to carry out vaccination activities as a routine daily service. The health workers maintained that special motivation should be allocated to those carrying out these services on the field, as it involves dangerous endeavors like climbing from one risk zone to another and descending in thick forests to go and vaccinate children.

Other participants concurred that parents have to take the vaccination of their children as a serious activity because there have been many outreach activities programmed whereby health workers go out to sensitize the community on the importance of vaccination. In the opinion of health workers, the provision of solar cold chain refrigerators to minimize the cost and long distance travel in order to purchase gas can greatly empower health facilities to sustain vaccination services. Health workers stated that: *"Community Health Workers (CHWs) can be trained and empowered to provide good vaccination services at various outreach posts. We have to create more outreach posts or centers in our communities, and use didactic materials (i.e., illustrative tools) when doing health education or sensitization in the communities so that the parents can better see and understand what is being done."*

It is envisaged that trained CHWs can contribute to enrolling more children for effective uptake of vaccination and to make it sustainable. Precise and informed sensitization, including good education on vaccination, was cited as possible avenues to exploit for improve parents' participation. Health workers also believed that parents should be appreciated for vaccinating their children, arguing that this can encourage others to emulate

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV October 2025 | Special Issue on Public Health

their example. The involvement of community stakeholders in vaccination activities to facilitate community acceptance of the services was also cited by the health workers.

DISCUSSIONS

Understanding the elements that predict childhood vaccine uptake is critical for designing effective public health strategies to improve immunization coverage. Results revealed that a significant (65.6%) proportion of parents having primary levels of education compared to those with tertiary levels of education. A study in Nigerian communities found a direct relationship between parental education and child vaccination rates, with parents holding higher education levels being likely to have their children vaccinated due to greater awareness, planning, and trust (Olasehinde & Joshua, 2025). A similar study conducted in Eritrea demonstrated that mothers who attended primary level education were more likely to have their children fully vaccinated than mothers who had not received any education (Kibreab et al., 2020).

However, in Africa, early marriages and pregnancies have undermined female education, thus retarding their vaccination awareness. Despite stakeholder initiatives in countries like Cameroon, Zambia, and South Africa, over 40% of girls still get married before the age of 18 years. In Niger, three out of four girls are married before the age of 18 years, and more than 2.6 million children are kept from the classroom. Coupled with limited financial assistance to enroll and isolation, many turn not to pursue education (Mulenga et al., 2018). There is the need to spark conversation on women's education and challenge norms that keep young women from reaching their potential in order to promote vaccination for posterity and sustainable development.

Effective uptake of immunization was constrained by vaccine stock-outs and inaccessibility. Hence, the geography and mobility issues have made it difficult for staff to navigate and arrive at vaccination sites or transport adequate vaccines from urban areas. This study compared the standard EPI target (85% to 90%) with that of the study area, noting the highest enrolment rate within the last nine years (2016−2024) was recorded in 2017 (71.4%). This rate dropped drastically within two years (2019 and 2020), with the lowest registered in 2020 (18.0%), attributed to the Anglophone crisis and the COVID-19 Pandemic. Also, parents living more than 5 km away from the healthcare facility remained 2.07 times more likely not to enroll in EPI activities than those living within 5 km distance. This corroborates the findings of Malison et al. (1987), who noted that most people in Africa live in rural areas where healthcare services are not easily accessible due to geographical and mobility issues.

The situation is even deteriorating as only 8.5% of vaccination coverage was recorded for a period of close to six months in 2020. This low rate was attributed to the political unrest in the District. The Anglophone crisis, which broke out in late 2016, has intensified various vulnerabilities to healthcare services, including vaccination. The key manifestations were the institution of lockdowns, "ghost towns," checkpoints, and insecurity characterized by kidnapping, burning of structures, and loss of lives. These factors have disrupted vaccination programs, health facility functionality, and mobility, thereby preventing fully vaccination enrollment. This situation reflects a similar experience in conflict-affected areas of Africa such as Libya, the Democratic Republic of Congo (DRC), and the Central African Republic, where vaccination efforts are constrained by various vulnerabilities and delays due to the destruction of health facilities and the susceptibility of healthcare systems (Abdullahi et al., 2020).

Culturally, the study revealed that there was a general notion that vaccines can be harmful or even lead to sterility. Furthermore, a study conducted in rural Nigeria revealed that full vaccination coverage was two-fold higher among children from non-Muslim families than children from Muslim families (Adebowale et al., 2019).

Farming activities were cited as a hindrance for most parents to enrolling their children for vaccination activities due to poverty and unemployment. Thus, parents engage in agriculture, taking their children alongside to farms for days and weeks as a safety net. The study findings show that there is a significant relationship between the economic conditions of households and vaccination coverage. To overcome these limitations, some countries have good health insurance policies, like Rwanda, where there is easy access to

health care services (Nyandekwe et al., 2020).

More so, from the caregivers' perspective, the periodic unavailability of vaccines in the healthcare facilities has discouraged most parents from returning to the facilities for subsequent doses after travelling long distances. Also, the discomfort faced by parents after vaccinating their children was cited as a barrier to routine vaccination due to the anxiety and stress following child vaccination. Furthermore, healthcare workers themselves desire the provision of solar cold chain refrigerators, which would minimize the cost and logistical burden associated with purchasing gas. This measure would greatly empower healthcare facilities to sustain the correct management of vaccines and vaccine supplies, enabling them to carry out vaccination activities as part of a routine daily service.

Special motivation should also be allocated to staff responsible for vaccination activities. It is also envisaged that CHWs could be selected, trained, and empowered to offer EPI activities within their respective communities. This would reduce the workload on the few available healthcare personnel and make vaccination more sustainable in the district. Health education and sensitization campaigns in the communities should be intensified so that parents are better informed on the importance of vaccination, as demonstrated in other settings such as Rwanda (Nyandekwe et al., 2020). The involvement of community stakeholders in vaccination activities to facilitate community acceptance of the services was also recommended by the health workers.

CONCLUSION AND RECOMMENDATIONS

The Benakuma Health District is experiencing a profound public health crisis, evidenced by the severe collapse in immunization coverage from 71.40% in 2017 to a trough of 18.00% in 2020. This trend directly impedes the achievement of Cameroon's national EPI targets of 85% to 90%. The sustained high proportion of not-enrolled children and the resulting absence of herd immunity demonstrate an extreme community vulnerability to vaccine-preventable disease outbreaks despite the slight improvement in EPI in 2024 (52.00%). This crisis is strongly correlated with a combination of contextual issues (conflict, religious and cultural beliefs), systemic failures (health system deficiencies), and significant barriers to service access and demand, which require urgent, differentiated public health action to limit the impact of the outbreak of vaccine preventable diseases on health and development.

Given the complexity and interconnectedness of these challenges, a multi-faceted approach is necessary to effectively address them. This approach must not only focus on improving access to vaccines but also on building trust within the community, enhancing the capacity of the health system, and ensuring that interventions are adaptable to the dynamic context of the district. In the light of these considerations, the following strategies are recommended to improve immunization outcomes in the district:

There is the need to deploy mobile vaccination clinics to remote and marginalized communities, ensuring that those who are hardest to reach are not left behind in vaccination efforts. Hence, a sustained, intensive, and likely mobile-based Expanded Programme on Immunization (EPI) strategy is required to bridge the massive gaps and achieve the 85% to 90% national target in the region. Furthermore, stakeholders should introduce performance-based incentives to motivate workers, including community champions, to achieve high vaccination rates, improve data quality, while engaging the community effectively. Health actors should also increase accessibility by extending clinic hours and establishing convenient vaccination points to reduce accessibility challenges, making it easier for individuals to get vaccinated. Moreover, the government should ensure targeted campaigns are carried out to help address misinformation about vaccines and increase awareness of their importance, thus helping to build community support for immunization programs. Improving vaccination supply chain management and providing regular training of CHWs under close supervision are essential steps to ensure smooth operations. Inclusive planning and implementation of immunization programs can help build trust and ensure interventions are culturally acceptable, appropriate, and effective. Given the security situations in the region, it is essential to develop programming that takes into account the local security context, ensuring the safety of both participants and the healthcare workers. Finally, there is the need for a strong monitoring and evaluation framework necessary to track progress, identify challenges, and inform decision-making, ensuring that interventions are effective and responsive to the needs of the population

Limitations of the Study

This study acknowledges several limitations, including limited data availability, sampling bias, recall bias, cultural and linguistic barriers, conflict and insecurity, limited generalizability, and resource constraints. Various strategies were employed to mitigate these, such as prioritizing accessible health facilities for data collection, using stratified sampling to ensure equal representation, and the use of health records, vaccination cards, interviews, and FGDs to ensure reliability. These strategies have provided detailed insights into the challenges facing the EPI in the study area, ultimately contributing to improved vaccination coverage and health outcomes in the region.

Competing Interests

The authors declare no competing interest.

Author's Contribution

IUT received the study, participated in data collection, analysis, interpretation and drafted the manuscript. BA participated in the drafting and revising the manuscript for academic content. ASN participated in supervising materials and methods used, and revised the manuscript. ODK participated in revising the manuscript. DSN supervised the research protocol, data collection and analysis.

ACKNOWLEDGMENTS

We will like to thank the University of Buea and especially to the Department of Public Health and Hygiene, for the wonderful quality and professional training. Special thanks go to; the District Medical Officer , Chairman of the Benakuma Health District, Health Personnel and the participants who took part in this study. Above all my special thanks to the Almighty ALLAH for His infinite Love and Grace.

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