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Factors Associated with Zero-Dose Status Among Children Aged 12–23 Months in the Mobayi-Mbongo Health Zone, North Ubangi Province, Democratic Republic of the Congo, from January to December 2024: A Cross-Sectional Study

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Research Article

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Factors Associated with Zero-Dose Status Among Children Aged 12–23 Months in the Mobayi-Mbongo Health Zone, North Ubangi Province, Democratic Republic of the Congo from January to December 2024 : A Cross-Sectional Study"

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Abstract

Background : Zero-dose children—those who have not received any dose of the first dose of pentavalent vaccine (Penta1), remain a major public health concern in the Democratic Republic of Congo (DRC). Understanding the determinants of zero-dose status is essential for improving immunization coverage and reducing vaccine-preventable diseases.

Methods : An analytical cross-sectional study was conducted from January to December 2024. A three-stage cluster sampling technique was used to select 203 children aged 12–23 months across six health areas. Data were collected through structured electronic questionnaires (KoboCollect), direct observation, and vaccination card review. Statistical analyses were performed using SPSS version 25, with bivariate and multivariate logistic regression to identify associated factors.

Results : The prevalence of zero-dose children was 28.6% when combining vaccination card data and maternal declarations. Multivariate analysis revealed that Central African nationality of mothers/caregivers (AOR = 5.9; 95% CI : 3.01–11.58), lack of knowledge of vaccine-preventable diseases (AOR = 16.09; 95% CI : 3.35–77.29), young maternal age (<20 years) (AOR = 2.06; 95% CI : 1.10–3.86), and distance to vaccination sites >5 km (AOR = 4.22; 95% CI : 2.21–8.05) were significantly associated with zero-dose status.

Conclusion : Zero-dose prevalence remains high in the Mobayi-Mbongo Health Zone, driven by sociodemographic, knowledge-related, and geographic barriers. Targeted interventions focusing on refugee populations, health education, improved geographic accessibility, and support for young mothers are urgently needed to reduce inequities in immunization coverage.

Keywords : Zero-dose children, vaccination coverage, determinants, Mobayi-Mbongo, Democratic Republic of Congo, immunization barriers

1.1. BACKGROUND

Vaccination is one of the most effective public health interventions for preventing mortality, morbidity, and complications related to infectious diseases. Since its large-scale introduction, vaccination has saved millions of lives, particularly in low-income countries where access to healthcare remains limited [1,2].

In the 1970s, approximately five million children died every year from infectious diseases that could have been prevented through appropriate immunization. At that time, global vaccination coverage was below 5%. To address this situation, the World Health Organization (WHO) launched the Expanded Programme on Immunization (EPI) in 1974, aiming to immunize the most vulnerable populations by initially targeting six priority diseases: diphtheria, tetanus, pertussis, poliomyelitis, measles, and tuberculosis [2]. In 2021, vaccination coverage against diphtheria, tetanus, and pertussis reached 81%. According to WHO, more than 2.5 million lives of children under five years of age are saved each year through vaccination [5]. The United Nations Children's Fund (UNICEF) estimates this figure at 4.4 million, further confirming the central role of vaccines in reducing child mortality [5].

However, despite these advances, millions of children still do not benefit from vaccination. Among them, "zero-dose children," defined as children aged 12–23 months who have not received any dose of the first dose of pentavalent vaccine (Penta1), remain a major public health concern. They account for nearly half of vaccine-preventable deaths in Gavi-supported low-income countries, although they represent a minority of unvaccinated children [9]. In 2019, five countries alone (Nigeria, India, the Democratic Republic of the Congo, Pakistan, and Ethiopia) accounted for two-thirds of zero-dose children worldwide [9].

In 2020, among the 72.5 million children targeted for immunization by Gavi in low-income countries, 12.4 million received no vaccine dose. This number increased to 18.1 million in 2021 before declining to 14.3 million in 2022, reflecting the persistent effects of health crises and structural barriers [9,10,11]. Globally, between 2019 and 2021, 67 million children did not receive all routine vaccines, including 48 million who received no vaccines at all [11].

The countries most affected include Myanmar (57% of children being zero dose), the Philippines (45%), Indonesia (29%), and Brazil (28%) [11,12]. In Africa, although the prevalence of zero-dose children decreased from 43% in 2000 to 22% in 2020, rates remain high in several countries, including the Central African Republic (46%), Nigeria (30%), and Chad (27%) [14].

In the Democratic Republic of the Congo (DRC), a vaccination coverage survey conducted by the School of Public Health (ECV 2021) estimated the proportion of zero-dose children at 19.1% [16]. The country has implemented initiatives such as the Mashako Plan, launched in 2019, to improve vaccination coverage. This plan, based on strong coordination between health authorities and partners, has resulted in notable progress. However, significant regional disparities persist, particularly in rural and remote areas.

North Ubangi Province illustrates these disparities. Although the proportion of zero-dose children in this province is lower than the national average, some health zones, such as Mobayi-Mbongo, show alarming rates. According to the 2022 Vaccination Coverage Survey (ECV 2022), 20% of children in this area had not received the first dose of pentavalent vaccine [16].

These inequalities in access to healthcare services are often exacerbated by geographical, economic, and sociocultural barriers.

Given this situation, identifying the specific factors contributing to non-vaccination in these areas is essential. Accurate identification of these factors will help design targeted and context-specific interventions to reduce the number of zero-dose children, improve vaccine equity, and strengthen efforts to combat vaccine-preventable diseases.

1.2. LITERATURE REVIEW

Vaccination is one of the most effective public health interventions for preventing mortality, morbidity, and complications associated with infectious diseases. It involves the administration of an antigenic preparation that stimulates a protective immune response capable of preventing disease or reducing its clinical severity. In the Democratic Republic of the Congo (DRC), vaccination is provided through the Expanded Programme on Immunization (EPI).

Several epidemiological studies have been conducted worldwide to identify factors associated with zero-dose status among children aged 12–23 months. These studies have highlighted the influence of maternal education, household socioeconomic status, place of residence, parental characteristics, and access to health services, among other factors.

In a study conducted in six health districts in Cameroon, Yakum et al. investigated factors associated with complete vaccination and zero-dose status among children aged 12–59 months. They reported a zero-dose prevalence of 16%. Higher maternal educational attainment and living in the same household as the father were significantly associated with a higher likelihood of complete vaccination. Conversely, several factors were associated with a lower probability of being zero-dose, including higher maternal education, living with the father, belonging to a higher household wealth quintile (third to fifth quintiles), and having a biological parent as the child's primary caregiver [13]. These findings suggest that both family structure and socioeconomic conditions may play an important role in children's access to routine immunization.

Similarly, in 2018, Kouyaté Abdoulaye investigated the causes of vaccination dropout among children aged 0–11 months attending the Siribala Community Health Center in the Niono Health District, Ségou Region, Mali. The study identified several factors associated with zero-dose or incomplete vaccination status. These included younger maternal age (18%), lack of maternal education (87%), the child's sex, the mother's marital status, maternal occupation, and knowledge of vaccine-related adverse events [18]. These findings highlight the importance of maternal sociodemographic characteristics and knowledge in determining children's utilization of vaccination services.

In the Democratic Republic of the Congo, Ishoso et al. investigated the reasons why children aged 12–23 months remained zero-dose or under-vaccinated. They found that 38.5% of the children included in the study were zero-dose. The reasons reported by caregivers were mainly related to perceptions and attitudes toward vaccination (64.03%), social factors (31.13%), and practical barriers (36.60%). Lack of motivation among parents or caregivers to have their children vaccinated was reported in 82.15% of cases [19]. These findings suggest that barriers to vaccination are multifactorial and extend beyond the physical availability of vaccination services.

In a comparative analysis of two approaches for assessing the burden of zero-dose children and their vulnerability profiles across 82 low- and middle-income countries, Wonodi et al. reported a zero-dose prevalence of 14.2%. The main factors associated with zero-dose status included having a mother with no formal education (51%), living in a rural area (65.3%), having an adolescent mother, and belonging to the poorest household wealth quintile (36%) [24]. These findings reinforce the role of socioeconomic and demographic inequalities in shaping access to childhood vaccination.

In another study conducted in the Democratic Republic of the Congo entitled Zero-dose children in the Democratic Republic of the Congo: How many are there and who are they?, Ishoso et al. found that zero-dose status was associated with low maternal educational attainment and having a young mother or caregiver (≤19 years of age). Other associated factors included religious affiliation, household wealth indicators, lack of access to communication devices such as a telephone or radio, having to pay for a vaccination card or other vaccination-related services, and inability to name at least one vaccine-preventable disease [22]. These findings indicate that both socioeconomic deprivation and limited knowledge about vaccination may contribute to persistent zero-dose status.

Nguefack et al., in a study examining the determinants and reasons for incomplete vaccination among hospitalized children in two pediatric referral hospitals in Yaoundé, Cameroon, found that the main reported reasons for incomplete vaccination were lack of knowledge or awareness (65.9%), vaccine stock-outs (21%), and maternal educational level [21]. This study underscores the fact that vaccination gaps may result from both demand-side factors, such as caregivers' knowledge, and supply-side constraints, such as interruptions in vaccine availability.

In another study investigating factors associated with zero-dose vaccination status in an isolated fishing community in Cameroon, Nchinjoh et al. reported that 91.7% of the children included in the study were zero-dose. Factors associated with zero-dose status included being born at home, having a non-Christian mother, having an immigrant father, and being younger in age [23]. These findings illustrate the particular vulnerability of geographically isolated communities, where social, cultural, and health-system barriers may interact to limit access to routine immunization services.

Overall, the evidence from these studies indicates that zero-dose status is a multifactorial phenomenon resulting from the interaction of individual, household, socioeconomic, sociocultural, geographical, and health-system factors. Maternal education, household wealth, parental characteristics, place of residence, knowledge and perceptions regarding vaccination, and the availability of vaccination services repeatedly emerge as important determinants. However, the relative importance of these factors varies according to the local context. This highlights the need for context-specific studies to identify the determinants of zero-dose status in underserved areas such as the Mobayi-Mbongo Health Zone in North-Ubangi Province, Democratic Republic of the Congo.

1.3. CONCEPTUEL FRAMEWORK

The conceptual framework guiding this study was designed to identify and analyze the factors associated with children presenting a zero-dose vaccination status in the Mobayi-Mbongo Health Zone**.**

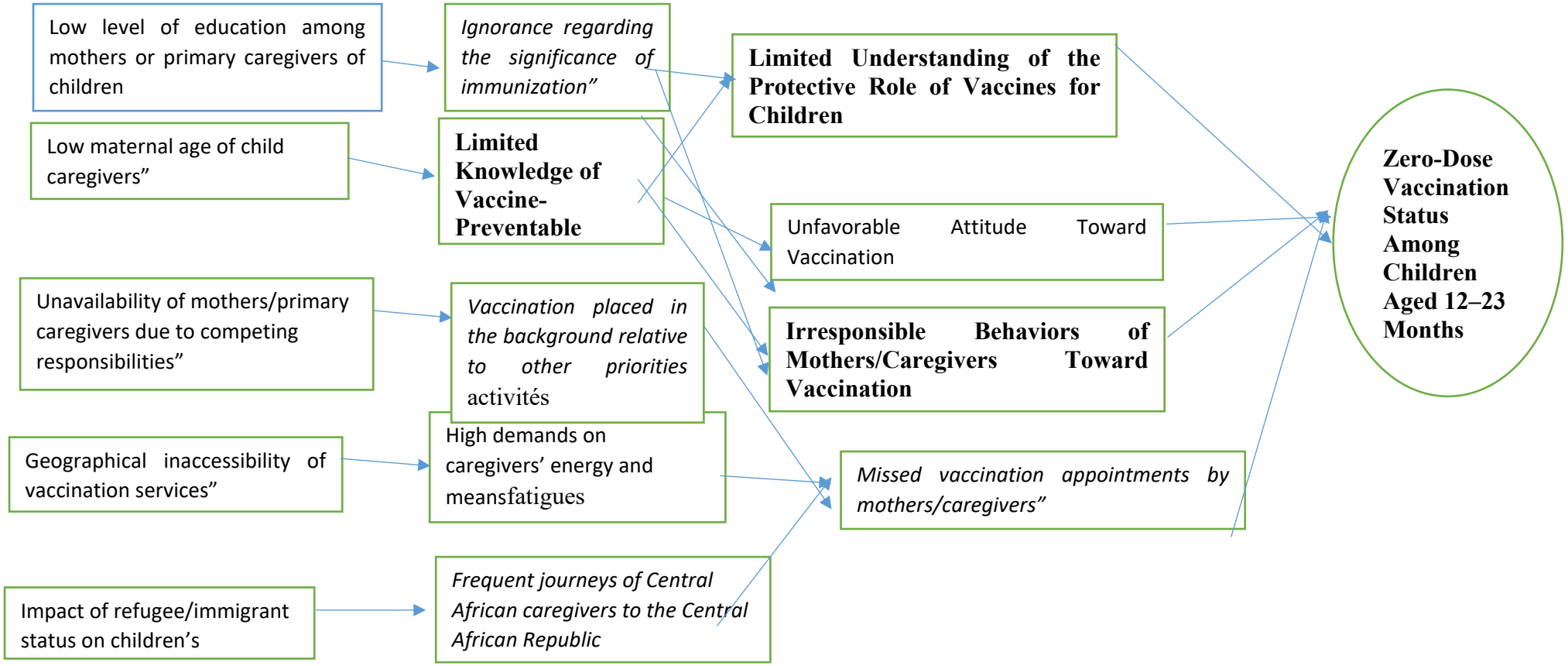


Figure 1 **:** Conceptual Framework of Factors Associated with Zero-Dose Children (12–23 months) in Mobayi-Mbongo Health Zone

1.4. AIM AND OBJECTIVES OF THE STUDY

1.4.1. Aim of the Study

This study aims to contribute to reducing the prevalence of zero-dose children in the Mobayi-Mbongo Health Zone.

1.4.2. General Objective

The general objective of this study is to determine the factors associated with zero-dose vaccination status among children aged 12–23 months in the Mobayi-Mbongo Health Zone.

1.4.3. Specific Objectives

The specific objectives of this study are to :

- ✓ describe the sociodemographic characteristics of household heads, mothers or caregivers, and children aged 12–23 months in the Mobayi-Mbongo Health Zone;
- ✓ assess mothers' or caregivers' level of knowledge regarding childhood vaccination in the Mobayi-Mbongo Health Zone;
- ✓ determine the prevalence of zero-dose children in the Mobayi-Mbongo Health Zone;
- ✓ describe the reasons for non-vaccination among zero-dose children in the Mobayi-Mbongo Health Zone; and
- ✓ identify the factors associated with zero-dose status among children aged 12–23 months in the Mobayi-Mbongo Health Zone.

II. METHODOLOGY

2.1. Study Setting

The study was conducted in the Mobayi-Mbongo Health Zone (HZ), located within the Provincial Health Division of Nord-Ubangi (DPS/NUB).

This is a rural health zone covering an area of **4,028 km²**, bounded by natural borders:

North : the Ubangi River, separating it from the Central African Republic (CAR).

East : the Lenge stream, separating it from the Yakoma Health Zone.

West : land separating the village of Bogonda (Mobayi side) from Komenge (Bosobolo Health Zone side).

South : land separating the village of Maniko (Mobayi side) from Bogonda (Loko Health Zone side).

With a population density of 27 inhabitants per km², the zone comprises 19 health areas distributed across 6 surveillance axes, and includes 26 health facilities, among which are 2 general referral hospitals and 4 referral health centers. It is composed of 2 sectors, 27 groupings, and 172 localities.

The local population primarily engages in agriculture, fishing, hunting, and small livestock farming, within an environment of forests and savannahs, characterized by alternating dry and rainy seasons.

The health zone also hosts a special population of Central African refugees, distributed between the INKE and NZAKARA camps (17,670 individuals) and host families across 10 health areas (33,665 individuals). These refugees arrived between 2013 and 2021, according to data from the General Directorate of Migration (DGM), the National Commission for Refugees (CNR), and Community Relays (RECOs).

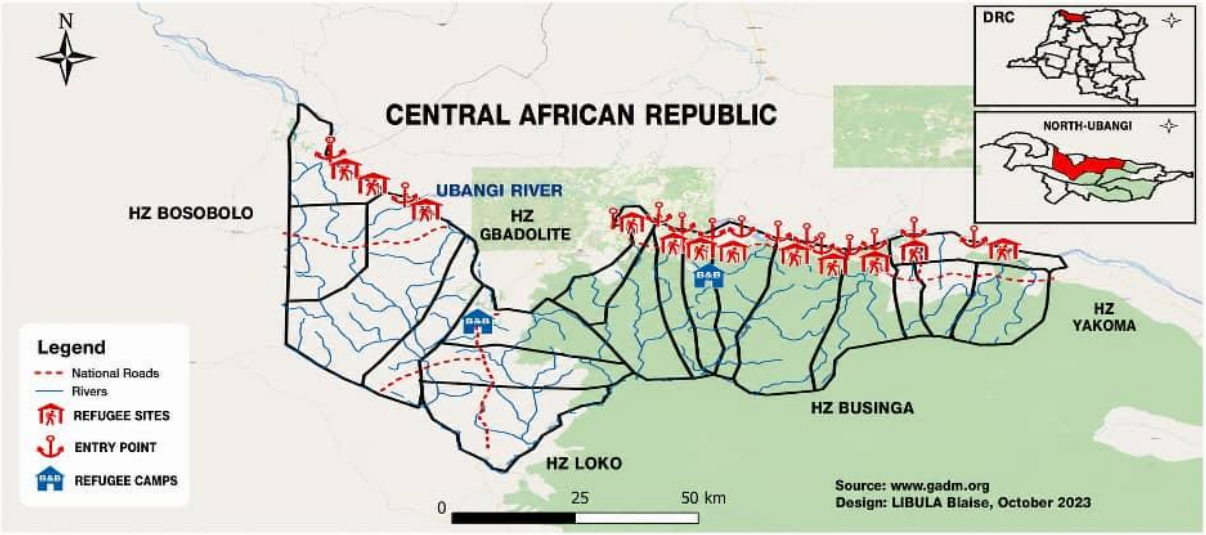


Figure 2 : Health map of the Mobayi-Mbongo Health Zone

Source : Health Information Office, North-Ubangi Provincial Health Division (DPS/NUB)

2.2. Study Design And Study Period

This was a cross-sectional analytical study conducted to identify factors associated with zero-dose vaccination status among children aged 12–23 months in the Mobayi-Mbongo Health Zone. The study was conducted from January to December 2024.

2.3. Sampling

2.3.1. Study Population

The study population consisted of children aged 12–23 months living in selected households within the Mobayi-Mbongo Health Zone during the study period.

2.3.2. Statistical Units

Three distinct statistical units were considered in this study :

Children aged 12–23 months: Information collected included age, sex, birth registration status, possession of a vaccination card, and the dates on which each vaccine antigen had been administered.

Mothers or caregivers of children aged 12–23 months: Information collected included their knowledge and perceptions regarding vaccination, as well as sociodemographic characteristics such as religion, educational attainment, age, occupation, marital status, and place of residence.

Households with at least one child aged 12–23 months: Information collected included household size, the number of children under five years of age, and the number of children aged 12–23 months.

2.3.3. Inclusion Criteria

Participants were eligible if they met the following criteria: living in a household with at least one child aged 12–23 months in the Mobayi-Mbongo Health Zone; and providing informed consent to participate in the study as a household head, mother, or caregiver of an eligible child.

2.3.4. Non-Inclusion Criteria

The following were excluded from the study:

Children aged 12–23 months who had been living in the Mobayi-Mbongo Health Zone for less than three months;

Children aged 12–23 months whose mother or caregiver was unavailable or unable to provide reliable information regarding the child's vaccination history; and

mothers or caregivers of children aged 12–23 months with behavioral disorders that prevented them from participating adequately in the interview.

2.4. Sample Size

The sample size was calculated based on the estimated prevalence of zero-dose children in the Mobayi-Mbongo Health Zone.

The Mobayi-Mbongo Health Zone belongs to the rural stratum. According to the 2022 Vaccination Coverage Survey (ECV 2022), the prevalence of zero-dose children aged 12–23 months in the Mobayi-Mbongo Health Zone was estimated at 20% ($p = 0.20$), with $q = 1 - p = 0.80$.

A 95% confidence level was used, corresponding to a Z-score of 1.96, with a type I error level of 5%. Given the three-stage cluster sampling design, a design effect (DEFF) of 3 was considered. The desired margin of error was set at 10% ($d = 0.10$).

The minimum sample size was calculated using the following formula:

$$n \geq Z2 \times p \times q \times DEFFd2$$

Where:

n = minimum required sample size;

Z = standard normal value corresponding to a 95% confidence level (1.96);

p = estimated prevalence of zero-dose children aged 12–23 months in the Mobayi-Mbongo Health Zone (20%, based on ECV 2022);

$q = 1 - p$ (0.80);

DEFF = design effect (3);

d = desired margin of error (0.10).

Thus:

$$n=(1.96)2 \times 0.20 \times 0.80 \times 3(0.10)2$$

$$n=184.4$$

The minimum required sample size was therefore approximately 184 children aged 12–23 months.

To account for a potential 10% non-response rate, the sample size was increased by 10%:

$n_{adjusted} = 184.4 \times 1.10 = 202.84$

After rounding up to the nearest whole number, the final sample size was 203 children aged 12–23 months.

A total of 203 children aged 12–23 months were included in the study.

2.5. Sampling Procedure

A three-stage cluster sampling procedure was used.

First stage: Selection of health areas

The Mobayi-Mbongo Health Zone comprises 19 health areas, which were organized into six supervision axes by the health-zone management team. One health area was selected from each supervision axis using stratified sampling, resulting in six selected health areas.

The target sample of 202 children was distributed among the six selected health areas proportionally to their respective population sizes.

Second stage : Selection of villages

Within each selected health area, all villages with a population of at least 200 inhabitants were first listed. Three villages were then selected from this list using simple random sampling.

The sample allocated to each health area was distributed among the selected villages proportionally to their respective population sizes. Households were subsequently selected using a systematic random sampling procedure.

Third stage: Selection of households

Within each selected village, a household enumeration exercise was conducted to identify residential plots containing at least one household with a child aged 12–23 months. A sampling interval was calculated based on the total number of eligible plots identified.

One eligible household was selected from each sampled plot. If more than one eligible household was present within the same plot, one household was selected by simple random sampling.

In each selected household, the mother or caregiver of a child aged 12–23 months was interviewed.

2.6. Key Variables

2.6.1. Dependent Variable : Zero-Dose Vaccination Status

Zero-dose children were defined as children aged 12–23 months who had received no dose of the first pentavalent vaccine (Penta-1) through the routine Expanded Programme on Immunization (EPI).

The pentavalent vaccine protects against diphtheria, tetanus, pertussis, Haemophilus influenzae type b (Hib), and hepatitis B.

2.6.2. Independent Variables

The independent variables included sociodemographic characteristics of mothers or caregivers and household heads, including sex, age, educational attainment, religion, place of residence, marital status, occupation, nationality, and ethnicity.

Maternal or caregiver age was categorized as <20 years and ≥20 years. Educational attainment was categorized as primary, secondary, and higher/university education.

Child-related sociodemographic variables included sex and age.

Mothers' or caregivers' knowledge of vaccination

Several indicators were used to assess mothers' or caregivers' knowledge of vaccination.

Knowledge of vaccine types : Mothers or caregivers who were able to name at least one vaccine administered to children were considered to have an acceptable level of knowledge, whereas those who could not name any vaccine were classified as having a low level of knowledge.

Knowledge of vaccine-preventable diseases : Mothers or caregivers who could identify at least one vaccine-preventable disease were considered to have an acceptable level of knowledge, whereas those who could not identify any vaccine-preventable disease were considered to have a low level of knowledge.

Perceived importance of vaccination : Mothers or caregivers who considered vaccination important for protecting their children were classified as having an acceptable level of knowledge, whereas those who did not consider vaccination important were classified as having a low level of knowledge.

Knowledge of the vaccination schedule: Mothers or caregivers who reported being able to remember their children's vaccination appointments were considered to have an acceptable level of knowledge, whereas those who were unable to remember vaccination appointments were considered to have a low level of knowledge.

Other vaccination-related variables included possession of a vaccination card, vaccination status for each antigen, dates of vaccination for each antigen, participation in vaccination campaigns, and reasons for non-vaccination.

2.7. Data Collection Techniques

Data were collected through face-to-face interviews with mothers or caregivers using a structured electronic questionnaire administered through KoboCollect. The questionnaire was pretested in a health area that was not included in the study.

Interviews were generally conducted in the morning and evening, when respondents were most likely to be at home.

Data collection also involved direct observation and review of children's vaccination cards, when available, in order to verify vaccination status and the dates on which vaccine antigens had been administered. Mothers or caregivers of children aged 12–23 months were also interviewed regarding vaccination history and reasons for non-vaccination.

The research team worked with the health-zone nurse supervisor responsible for epidemiological surveillance, the head nurses of the selected health areas, the presidents of the Health Development Committees (PRESICODESA), and community health workers (RECOS) to identify and locate households with children aged 12–23 months.

The Health Development Committee (CODESA) is a community participation structure established by the Ministry of Health at the health-area level. It is largely composed of community health workers (RECOS), together with other community leaders. Community health workers are members of the community who are elected or selected by the population on a voluntary basis to carry out health-related activities of community interest under the supervision of the head nurse of the health center.

2.8. Data Collection Procedures

2.8.1. Ethical Approval

Before data collection began, ethical approval was obtained from the Ethics Committee of the Kinshasa School of Public Health. The study was authorized under approval number ESP/CE/231/2024.

2.8.2. Recruitment, Training, and Organization of the Field Team

Data were collected by three interviewers, including both male and female interviewers, under the supervision of the field supervisor, who was also the principal investigator. The field supervisor was responsible for coordinating and overseeing implementation of the study in the Mobayi-Mbongo Health Zone.

To ensure the quality of data collection, the field supervisor and interviewers were selected from among health-zone personnel with previous experience in epidemiological surveys.

A two-day training session was organized for the field supervisor and interviewers. The training focused on the objectives and methodology of the vaccination coverage survey, interview techniques, informed consent procedures, questionnaire content, and the use of smartphones for electronic data collection.

The training included both theoretical and practical sessions. The first day focused on interview techniques, informed consent procedures, and a detailed review of the questionnaire. The second day focused on practical exercises and the use of smartphones for electronic data entry and submission.

At the end of the training, a pretest was conducted in a health area that was not selected for the study. The findings from the pretest were used to identify and correct potential problems with the questionnaire and data collection procedures before fieldwork began.

2.8.3. Administrative Authorizations

Administrative authorization to conduct the study was obtained from the Head of the North-Ubangi Provincial Health Division and the Medical Officer in Charge of the Mobayi-Mbongo Health Zone.

2.9. Data Management And Statistical Analysis

Data were collected electronically using KoboCollect and analyzed using IBM SPSS Statistics version 25. Statistical significance was assessed at the 5% level, with a p-value <0.05 considered statistically significant.

Descriptive statistics were used to summarize the characteristics of the study population. For quantitative variables, means and standard deviations were used to describe central tendency and dispersion. Categorical variables were summarized using frequencies and proportions.

The Pearson chi-square test was used to compare proportions between categorical variables when the assumptions of the test were met, particularly when the expected frequency was at least five.

Bivariate analysis was initially performed using the chi-square test to assess associations between independent variables and zero-dose vaccination status. Variables with a p-value <0.05 were considered for inclusion in the multivariable analysis.

Multivariable logistic regression analysis was then performed to estimate adjusted odds ratios (aORs) and corresponding 95% confidence intervals (95% CIs) and to identify factors independently associated with zero-dose vaccination status.

The final model retained variables that remained statistically significant after adjustment.

2.10. Ethical Considerations

Ethical approval for the study was obtained from the Ethics Committee of the Kinshasa School of Public Health under approval number ESP/CE/231/2024.

The study respected the principles of autonomy, confidentiality, anonymity, and voluntary participation. Informed consent was obtained from individuals who agreed to participate in the study.

Participants were informed that participation was voluntary and that they could withdraw from the interview at any time or decline to answer any question without any negative consequences.

Informed consent was obtained from the relevant health-area and community authorities, as well as from household heads, mothers, and caregivers participating in the study. No personally identifying information was included in the study database, thereby protecting the confidentiality and anonymity of participants.

The research team took measures to minimize any potential psychological discomfort or other constraints associated with participation. No preferential treatment was given to participants on the basis of socioeconomic status or any other personal or social characteristic.

III. RESULTS

3.1. Sample Characteristics

The study included 203 children aged 12–23 months across 6 health areas selected from the 18 that make up the Mobayi-Mbongo Health Zone. Voici une version harmonisée en anglais scientifique, adaptée au style d'un article destiné à BMC :

Table 2 presents the sociodemographic characteristics of the mothers/caregivers. The mean age was 24.33 years (SD : 5.9), with the age group >20 years being the most represented. More than three-quarters of the mothers/caregivers had a low level of education (83.7%). Catholicism was the most commonly practiced religion (42.0%). At least three-quarters of the mothers/caregivers were in a common-law union (73.4%). More than half of the mothers/caregivers were of Congolese nationality, and nearly all respondents were the children's biological mothers (92.6%).

Table 2 : Sociodemographic Characteristics of Mothers/Caregivers in the Mobayi-Mbongo Health Zone, January–December 2024

Variables	Frequency (n=203)	Percentage (%)
Relationship to the child		
Mother of the child	188	92.6
Caregiver of the child	15	7.4
Highest level of education		
Low	170	83.7
Acceptable	33	16.3
Occupation		
Farmer	85	41.8
Housewife	75	36.9
Unemployed	39	19.2
Fisherwoman	4	1.9
Religion		
Catholic	87	42.9
Protestant	60	29.6
Revival Church	47	23.2
Kimbanguist	8	3.9
Muslim	1	0.5
Marital status		
Consensual union	149	73.4
Married	36	17.7
Single	8	3.9
Separated	7	3.4
Widow	3	1.5
Nationality		

Variables	Frequency (n=203)	Percentage (%)
Congolese	146	71.9
Central African	57	28.1
Age group		
> 20 years	133	65.5
< 20 years	70	34.5
Variable	**Mean**	**SD**
Age	24.33	5.9

Table 3 presents the sociodemographic characteristics of children aged 12–23 months in the targeted health areas of the Mobayi-Mbongo Health Zone. The mean age of the children was 16.6 months (SD : 3.14). The sex distribution was nearly equal, with boys accounting for 50.9% and girls for 49.1%, corresponding to a sex ratio of 0.97. The majority of children did not have a birth certificate (83.8%), and most had not been registered with the civil registry. Nearly three-quarters of the children were partially vaccinated.

Table 3: Sociodemographic Characteristics of Children Aged 12–23 Months in the Targeted Health Areas of the Mobayi-Mbongo Health Zone, January–December 2024

Variables	Frequency (n=203)	Percentage (%)
Sex		
Female	103	50.7
Male	100	49.3
Availability of Birth Certificate		
No	171	84.2
Yes – Not Seen	18	8.9
Don't Know	10	4.9
Yes – Seen	4	2.0
Civil Registration/Declaration of the Child		
No	180	88.7
Don't Know	18	8.9
Yes	5	2.5
Age Group		
12–17 months	117	57.6
18–23 months	86	42.4
Variable	**Mean**	**SD**
Age	16.6	3.14

3.3. Prevalence of Zero-Dose

3.3.1. Prevalence of Zero-Dose Children Aged 12–23 Months According to Vaccination Card, Maternal Report, and Combined Sources Voici une version harmonisée, avec une formulation plus rigoureuse pour une publication scientifique BMC :

Table 4 presents the prevalence of zero-dose vaccination status among children aged 12–23 months in the Mobayi-Mbongo Health Zone. Among the 203 children included in the analysis, 31 (15.2%) who had vaccination cards were classified as zero-dose children. In addition, 27 children (13.3%) who did not have vaccination cards were classified as zero-dose based on their mothers' reports. When the two sources of information were combined, 58 of the 203 children (28.6%) were classified as having a zero-dose vaccination status.

Table 4 : Prevalence of Zero-Dose Children Aged 12–23 Months According to Vaccination Card, Maternal Report, and Combined Sources in the Mobayi-Mbongo Health Zone, January–December 2024

Source	Frequency (n=203)	Percentage (%)
Vaccination card	31	15.2
Maternal declaration	27	13.3
Combined sources	58	28.6

Table 5 presents the mothers'/caregivers' knowledge of vaccine-preventable diseases. The least recognized vaccine-preventable diseases among the respondents were pneumonia and meningitis, each reported by 0.5% of respondents. Diphtheria and hepatitis were not recognized by any of the respondents.

Table 5 : Knowledge of Mothers/Caregivers Regarding Vaccine-Preventable Diseases in the Mobayi-Mbongo Health Zone, January–December 2024

Variables	Frequency (n=203)	Percentage (%)
Poliomyelitis	171	84.2
Measles	93	45.8
Diarrhea	42	20.7
Yellow fever	35	17.2
Tuberculosis	21	10.3
Tetanus	9	4.4
Pertussis	8	3.9
Haemophilus influenzae	2	1.0
Pneumonia	1	0.5
Meningitis	1	0.5
Hepatitis	0	0
Diphtheria	0	0

Table 6 presents the main reasons for children not being vaccinated. The most frequently reported reasons were the mothers'/caregivers' lack of financial means to purchase vaccination cards (27.5%), mothers' travel to the Central African Republic during vaccination sessions among Central African refugee mothers (20.6%), children being ill during the vaccination period, lack of awareness of the vaccination date, and agricultural activities (13.7%). Maternal illness was also reported as a reason for non-vaccination (10.3%).

Table 6 : Reasons for Non-Vaccination of Children Aged 12–23 Months in the Mobayi-Mbongo Health Zone, July–December 2024

Variables	Frequency (n=58)	Percentage (%)
Lack of means to purchase vaccination card	16	27.5
Travel to Central African Republic	12	20.6
Child illness	8	13.7
Ignorance of vaccination date	8	13.7
Farming activities	8	13.7
Maternal illness	6	10.3

Table 7 shows that mothers/caregivers of Central African nationality had significantly higher odds of having zero-dose children compared with their Congolese counterparts (OR = 3.20; 95% CI: 2.09–4.89; p = 0.001). Mothers/caregivers who were unable to identify any vaccine-preventable disease also had significantly higher odds of having zero-dose children compared with those who could identify at least one vaccine-preventable disease (OR = 12.50; 95% CI: 2.85–54.66; p = 0.001).

Younger mothers/caregivers had significantly higher odds of having zero-dose children than older mothers/caregivers (OR = 1.57; 95% CI: 1.08–2.27; p = 0.022). Similarly, mothers/caregivers living more than 5 km from a vaccination site had significantly higher odds of having zero-dose children compared with those living closer to a vaccination site (OR = 2.11; 95% CI: 1.55–2.86; p < 0.001).

Table 7 : Sociodemographic Characteristics of Mothers/Caregivers and Children Associated with Zero-Dose Status in the Bivariate Model

Variables	Categories	Zero-Dose (Yes)	Zero-Dose (No)	OR	95% CI	p-value
Nationality	Congolese	26	120	1	–	–
	Central African	32	25	3.2	[2.09–4.89]	0.001*
Distance to vaccination site	≤ 5 km	20	100	1	–	–
	> 5 km	38	45	2.11	[1.55–2.86]	0.000*
Mother's age group	< 20 years	27	43	1.57	[1.08–2.27]	0.022*
	≥ 20 years	31	102	1	–	–

Variables	Categories	Zero-Dose (Yes)	Zero-Dose (No)	OR	95% CI	p-value
Marital status	Living alone	3	15	2.11	[0.58–7.6]	0.2
	In union	55	130	–	–	–
Mother's occupation	Remunerated profession	20	72	1.87	[0.99–3.52]	0.05
	Non-remunerated profession	38	73	1	–	–
Education level of mother/caregiver	Acceptable	9	24	–	–	–
	Low	49	121	0.94	[0.51–1.73]	0.85
Knowledge of vaccine-preventable diseases	None	10	2	12.50	[2.85–54.66]	0.000*
	At least one	32	103	0.77	–	–
Child's age group	18–23 months	28	58	1	–	–
	12–17 months	30	87	1.4	[0.75–2.58]	0.28
Child's sex	Female	30	73	1	–	–
	Male	28	72	0.94	[0.51–1.74]	0.8

Table 8 shows that, after adjustment for potential confounding factors, Central African nationality among mothers/caregivers (aOR = 5.90; 95% CI: 3.01–11.58; p < 0.001), inability to identify any vaccine-preventable disease (aOR = 16.09; 95% CI: 3.35–77.29; p = 0.001), younger maternal/caregiver age (aOR = 2.06; 95% CI: 1.10–3.86; p = 0.023), and living more than 5 km from a vaccination site (aOR = 4.22; 95% CI: 2.21–8.05; p < 0.001) were significantly associated with zero-dose children in the Mobayi-Mbongo Health Zone.

Table 8 : Factors Associated with Zero-Dose Status in the Multivariate Model (Logistic Regression)

Characteristics	Bivariate Analysis (OR)	95% CI	p-value	Multivariate Analysis (AOR)	95% CI	p-value
Central African nationality of mother/caregiver	3.2	[2.09–4.89]	0.001	5.9	[3.01–11.58]	0.000*
Maternal age < 20 years	1.57	[1.08–2.27]	0.022	2.06	[1.10–3.86]	0.023*
Lack of knowledge of vaccine-preventable diseases	12.50	[2.85–54.66]	0.000	16.09	[3.35–77.29]	0.001*

Characteristics	Bivariate Analysis (OR)	95% CI	p-value	Multivariate Analysis (AOR)	95% CI	p-value
Distance to vaccination site > 5 km	2.11	[1.55–2.86]	0.000	4.22	[2.21–8.05]	0.000*

IV. DISCUSSION

4.1. Main findings

This study assessed the prevalence and factors associated with zero-dose vaccination status among children aged 12–23 months in the Mobayi-Mbongo Health Zone, in North-Ubangi Province, Democratic Republic of the Congo (DRC). The study found that 28.6% of children aged 12–23 months were zero-dose, based on the combined information from vaccination cards and maternal/caregiver reports. This prevalence indicates a substantial gap in access to routine immunization services in the study area.

Several factors were significantly associated with zero-dose status after adjustment for potential confounders. These included Central African nationality of the mother/caregiver, maternal age below 20 years, lack of knowledge of at least one vaccine-preventable disease, and living more than 5 km from a vaccination site. These findings suggest that zero-dose vaccination status in Mobayi-Mbongo results from the interaction of individual, social, informational, and geographical barriers.

4.2. Prevalence of zero-dose vaccination

The prevalence of zero-dose children was 28.6% when vaccination cards and maternal reports were combined. This proportion is higher than the national estimate reported by the 2021 Vaccination Coverage Survey in the DRC, which estimated the proportion of zero-dose children at approximately 19.1% [16]. It is also higher than the 20% reported for the Mobayi-Mbongo Health Zone in the 2022 vaccination coverage survey [25].

The observed prevalence may reflect the specific vulnerabilities of the Mobayi-Mbongo Health Zone. The area is predominantly rural, characterized by difficult geographical accessibility, dispersed settlements and populations whose livelihoods depend largely on agriculture, fishing, hunting and small-scale livestock farming. These characteristics may limit regular access to health facilities and routine vaccination services.

The presence of Central African refugees may further increase the vulnerability of some households. The study area hosts refugees living both in camps and within host communities. Population mobility between the DRC and the Central African Republic may contribute to interruptions in routine immunization schedules, particularly when mothers travel during periods when vaccination sessions are organized. Indeed, travelling to the Central African Republic was reported as one of the main reasons for non-vaccination in this study.

The prevalence observed in this study is also consistent with evidence showing that zero-dose children tend to be concentrated among populations experiencing multiple forms of vulnerability, including poverty, geographical isolation, population displacement and limited access to health services [8,9,12,24]. Therefore, the relatively high prevalence observed in Mobayi-Mbongo should not be interpreted solely as a problem of parental refusal, but rather as the result of several interacting structural and household-level barriers.

4.3. Maternal and caregiver knowledge of vaccination

The study showed important gaps in mothers' and caregivers' knowledge of vaccine-preventable diseases. Although poliomyelitis and measles were relatively well recognized, several other vaccine-preventable diseases were poorly known. Pneumonia and meningitis were each mentioned by only 0.5% of respondents, while no respondent reported diphtheria or hepatitis.

This finding is important because knowledge about vaccination may influence caregivers' perceptions of the benefits of immunization and their motivation to seek vaccination services. In this study, mothers or caregivers who were unable to identify at least one vaccine-preventable disease had substantially higher odds of having a zero-dose child. In the multivariable model, the odds of zero-dose status were more than 16 times higher among children whose mothers or caregivers did not know any vaccine-preventable disease (AOR = 16.09; 95% CI: 3.35–77.29; p = 0.001).

This result is consistent with findings from the DRC reported by Ishoso et al., who identified limited knowledge and lack of motivation among parents or caregivers as important contributors to zero-dose and under-vaccination [19,22]. Similarly, studies conducted in other African settings have shown that inadequate knowledge and misconceptions about vaccination can contribute to incomplete vaccination [18,21].

However, the relationship between knowledge and vaccination should be interpreted within the broader context of access to services. Knowledge alone may not be sufficient to ensure that a child is vaccinated when families face long distances to vaccination sites, financial constraints, population displacement or competing livelihood activities. Thus, interventions aimed at reducing zero-dose vaccination should combine health education with measures that improve the physical and financial accessibility of vaccination services.

4.4. Maternal age and zero-dose vaccination status

Children of mothers or caregivers younger than 20 years were more likely to be zero-dose than children of older mothers. After adjustment, mothers younger than 20 years had approximately twice the odds of having a zero-dose child (AOR = 2.06; 95% CI: 1.10–3.86; p = 0.023).

This finding is consistent with previous evidence suggesting that adolescent or very young mothers may experience greater difficulties in accessing and using child health services. Young mothers may have less experience with childhood vaccination schedules, fewer financial resources, lower autonomy in household decision-making and greater dependence on other family members.

Wonodi et al. identified adolescent maternal age among the characteristics associated with zero-dose status across low- and middle-income countries [24]. Ishoso et al. also reported an association between zero-dose status and having a young mother or caregiver aged 19 years or younger in the DRC [22].

The findings therefore suggest that young mothers should be considered a priority group for immunization interventions. Community-based education, reminders for vaccination appointments and enhanced support from community health workers could be particularly useful for this group.

4.5. Geographical accessibility of vaccination services

Geographical distance was another important determinant of zero-dose vaccination. Children living in households located more than 5 km from a vaccination site had more than four times the odds of being zero-dose after adjustment (AOR = 4.22; 95% CI: 2.21–8.05; $p < 0.001$).

This association highlights the importance of geographical accessibility in rural immunization programs. In Mobayi-Mbongo, the large geographical area, dispersed settlements and transportation constraints may make it difficult for caregivers to reach vaccination services regularly. The effect of distance may be amplified by the economic cost of transportation and the opportunity cost associated with leaving agricultural or other livelihood activities.

The findings are consistent with the literature showing that children living in remote or underserved areas are disproportionately represented among zero-dose populations [9,12]. Studies from Cameroon have similarly demonstrated the importance of geographical and social isolation in explaining incomplete or absent childhood vaccination [23].

The strong association observed in this study suggests that improving the availability of vaccination services closer to communities could have a substantial effect on reducing zero-dose prevalence. Outreach and mobile vaccination sessions, integration of vaccination with other community health activities, and better planning of vaccination sessions in hard-to-reach areas could help reduce this geographical barrier.

4.6. Nationality and population mobility

Maternal/caregiver nationality was strongly associated with zero-dose status. Children of Central African mothers or caregivers had almost six times higher odds of being zero-dose than children of Congolese mothers or caregivers after adjustment (AOR = 5.90; 95% CI: 3.01–11.58; $p < 0.001$).

This finding is particularly relevant in the context of Mobayi-Mbongo, which hosts a substantial refugee population from the Central African Republic. Population displacement and mobility can disrupt continuity of routine health services, including vaccination. Refugee families may also face difficulties related to documentation, unfamiliarity with the health system, language or communication barriers, mobility between countries, and limited financial resources.

The finding is consistent with the broader literature indicating that displaced populations and populations affected by conflict are particularly vulnerable to being missed by routine immunization services [11,12]. The present study provides additional evidence that refugee and migrant populations should be explicitly considered in immunization microplanning.

The finding that travelling to the Central African Republic was the second most frequently reported reason for non-vaccination further supports the role of population mobility. Cross-border and mobile populations may therefore require specific vaccination strategies, including vaccination during outreach activities, strengthened documentation of vaccination history, coordination between health services on both sides of the border, and vaccination opportunities at points of contact with mobile populations.

4.7. Reasons for non-vaccination

The main reasons reported by caregivers for non-vaccination were lack of financial means to purchase the vaccination card, travel to the Central African Republic, childhood illness, lack of knowledge of the vaccination day, agricultural activities and maternal illness.

The fact that the cost of obtaining a vaccination card was the most frequently reported reason deserves particular attention. Although routine childhood vaccination is intended to be accessible to all children, additional costs associated with vaccination services may represent a barrier for poor households. Such costs may discourage caregivers from attending vaccination sessions and may disproportionately affect vulnerable populations.

The importance of agricultural activities is also understandable in this predominantly rural setting. Mothers and caregivers may be engaged in farming during vaccination sessions and therefore unable to bring their children to health facilities. Similarly, maternal illness can prevent caregivers from travelling with children to vaccination sites.

These findings reinforce the need to move beyond facility-based vaccination alone. Community-based and outreach vaccination services may reduce opportunity costs and improve access for households living far from health facilities or engaged in agricultural activities.

4.8. Other sociodemographic factors

In the bivariate analysis, children of female-headed households had higher odds of being zero-dose than children living in male-headed households. However, this variable was not retained in the final multivariable model. Similarly, maternal education was not significantly associated with zero-dose status in the present study.

The absence of a statistically significant association with maternal education should not necessarily be interpreted as evidence that education has no influence on vaccination. The effect of education may be mediated by other factors, including knowledge of vaccination, household socioeconomic conditions and physical access to services. In addition, the relatively small sample size may have limited the statistical power to detect associations involving some variables.

4.9. Comparison with previous studies in the DRC and sub-Saharan Africa

Overall, the findings of this study are consistent with the growing body of evidence showing that zero-dose children are concentrated among populations experiencing multiple vulnerabilities. Previous studies in the DRC identified young maternal age, low maternal education, socioeconomic disadvantage, limited knowledge and social or practical barriers as factors associated with zero-dose status [19,22]. Studies conducted in Cameroon similarly identified maternal characteristics, household conditions, geographical isolation and population mobility as important determinants of vaccination uptake [13,21,23].

However, the present study provides a specific perspective from a rural health zone in North-Ubangi, where the combination of geographical isolation and the presence of a large refugee population creates a distinctive context. The particularly strong associations observed with Central African nationality and distance to vaccination sites highlight the importance of context-specific interventions rather than relying exclusively on national-level strategies.

4.10. Public health implications

The findings have several implications for immunization programming in Mobayi-Mbongo and similar rural settings in the DRC.

First, vaccination services should be brought closer to populations living more than 5 km from existing vaccination sites through regular outreach and mobile vaccination activities. Second, refugee and mobile populations should be explicitly incorporated into health-zone immunization microplans. Third, young mothers should be targeted through community-based education, vaccination reminders and individualized follow-up.

Fourth, health education should emphasize not only the benefits of vaccination but also the diseases prevented by vaccines and the importance of completing the vaccination schedule. Community health workers and local leaders can play a key role in disseminating this information.

Finally, barriers related to the cost of vaccination-related materials should be reviewed to ensure that indirect financial barriers do not prevent children from accessing routine immunization.

4.11. Strengths and limitations of the study

This study has several strengths. First, it used an analytical cross-sectional design that allowed the identification of factors associated with zero-dose vaccination status. Second, vaccination status was assessed using both vaccination cards and maternal reports, which allowed the identification of zero-dose children who might otherwise have been missed when relying on a single source. Third, the study used a three-stage cluster sampling approach covering several health areas, thereby improving the geographical representation of the selected population. Finally, the use of electronic data collection through KoboCollect likely reduced data-entry errors and facilitated data management.

Nevertheless, several limitations should be considered. First, the cross-sectional design does not allow causal relationships to be established between the identified factors and zero-dose status. Second, some vaccination information was based on maternal recall, which may have introduced recall bias, particularly among caregivers who did not possess vaccination cards. Third, the relatively small sample size may have resulted in wide confidence intervals for some associations, particularly for the maternal knowledge variable. Fourth, the study was conducted in selected health areas and may therefore not be fully generalizable to the entire Mobayi-Mbongo Health Zone or to other rural areas of the DRC.

Despite these limitations, the consistency of the findings across several domains—geographical access, maternal characteristics, knowledge and population mobility—supports their relevance for local immunization planning.

4.12. Future Research

Future studies should aim to:

- **Conduct longitudinal research** to better establish causal relationships between sociodemographic factors and vaccination outcomes.
- **Expand geographic coverage** to include multiple health zones across Nord-Ubangi and other provinces, allowing for broader generalization of findings.
- **Integrate qualitative approaches** (e.g., focus groups, in-depth interviews) to explore cultural beliefs, perceptions, and barriers to vaccination in greater depth.

- **Assess health system performance** by evaluating vaccine supply chains, outreach strategies, and the role of community health workers in improving coverage.
- **Examine intervention effectiveness** by piloting targeted strategies (mobile vaccination units, refugee-focused programs, adolescent mother support initiatives) and measuring their impact on reducing zero-dose prevalence.

V. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The prevalence of zero-dose children in the study Health Zone was 28.6%. The main reasons for non-vaccination included financial constraints related to the purchase of vaccination cards, travel to the Central African Republic among refugee mothers during vaccination sessions, and maternal or child illness and other competing activities. Multivariable logistic regression analysis showed that Central African nationality among mothers/caregivers, inability to identify vaccine-preventable diseases, younger maternal/caregiver age, and living more than 5 km from a vaccination site were significantly associated with zero-dose vaccination status.

5.2. Recommendations

Several strategic interventions should be considered to reduce the prevalence of zero-dose children in the Mobayi-Mbongo Health Zone. First, vaccination cards should be provided free of charge, with measures to eliminate any direct or indirect costs perceived by families. This may require stronger monitoring of practices at local health facilities and increased community awareness regarding the right to free vaccination services [19, 21].

Second, community-based health education activities should be strengthened and adapted to the population's educational level. These interventions should emphasize the importance of routine childhood vaccination, improve mothers' and caregivers' knowledge of vaccine-preventable diseases, and address misconceptions regarding vaccine safety and effectiveness [24].

Third, geographical and organizational barriers to vaccination should be reduced. The establishment of mobile vaccination services in remote villages and the organization of vaccination sessions outside periods of intensive agricultural activity could improve access for rural households [18, 22].

Finally, specific strategies should be developed for refugee populations. Vaccination activities could be coordinated with humanitarian interventions, such as food distributions and population registration or enumeration activities, to increase opportunities for identifying and vaccinating eligible children [23]. Strengthening coordination between health services, humanitarian actors, community leaders, and refugee communities may further contribute to improving vaccination coverage and reducing the number of zero-dose children in the Health Zone.

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