

# Geographical Disparities and Missed Communities Influencing DTP1 and DTP3 Vaccination Coverage Among Children Aged 12–35 Months: Evidence from the Far North Region of Cameroon

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## Abstract:

### ➤ *Background:*

Vaccination coverage in Cameroon remains uneven, with the Far North region exhibiting some of the highest concentrations of “zero-dose” children. Geographical disparities including remoteness, displacement, and mobility are critical determinants of missed immunization opportunities. This study assessed the association between geographical disparity factors and vaccination coverage (DTP1 and DTP3) among children aged 12–35 months.

### ➤ *Methods:*

A cross-sectional survey was conducted among mothers of children aged 12–35 months in the Far North region of Cameroon. Data were collected through household interviews and vaccination card verification (N=383). Multivariate logistic regression was used to examine associations between geographical factors (mountain communities, conflict-affected areas, distance >10 km from health facilities, internally displaced persons, nomadic groups, refugee camps, and urban slums) and vaccination outcomes (DTP1 and DTP3). Odds ratios (OR), 95% confidence intervals (CI), and p-values were reported.

### ➤ *Results:*

Children living more than 10 km from health facilities were over five times more likely to miss DTP1 (OR = 5.11, CI [2.47–10.56],  $p < 0.001$ ). Nomadic children were more than three times as likely to miss vaccination (OR = 3.73, CI [1.52–9.17],  $p < 0.01$ ). Children in refugee camps were nearly eight times more likely to remain unvaccinated (OR = 7.69, CI [2.76–21.39],  $p < 0.001$ ). Internally displaced children had significantly lower odds of vaccination (OR = 0.11, CI [0.04–0.36],  $p < 0.001$ ). Results for DTP3 mirrored those of DTP1, confirming the persistence of disparities across the vaccination schedule.

### ➤ *Conclusion:*

Geographical disparities including distance from health facilities, displacement, nomadic lifestyles, and refugee camp residence are strong predictors of missed vaccination in Cameroon’s Far North region. Targeted interventions such as mobile vaccination units, integration of services in refugee camps, and infrastructure investment are urgently needed to reduce inequities and improve immunization coverage among vulnerable populations.

**Keywords:** *Geographical Disparities, Vaccination Coverage, DTP1 and DTP3, Children Aged 12–35 Months, Far North Cameroon.*

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## I. INTRODUCTION

Vaccination is a cornerstone of child survival, yet coverage remains uneven across Cameroon. The Far North region, marked by insecurity, displacement, and fragile health infrastructure, has some of the country's largest pockets of "zero-dose" children those who have not received even a first dose of diphtheria-tetanus-pertussis (DTP1). These disparities threaten national immunization goals and increase the risk of outbreaks of vaccine-preventable diseases.

Geographical disparities are a critical determinant of vaccination coverage. Children living in remote mountainous areas or communities located more than 10 kilometers from health facilities face significant barriers to accessing routine immunization. Physical distance translates into increased travel time, transportation costs, and opportunity costs for caregivers. Recent geospatial analyses in Cameroon confirm that distance to health facilities is one of the strongest predictors of incomplete vaccination schedules, particularly for multi-dose vaccines such as DTP3 (Saidu et al., 2024)

Conflict and insecurity further exacerbate these challenges. The Far North has been affected by insurgency, which disrupts health service delivery and discourages caregivers from seeking care. Health workers face risks in insecure zones, leading to irregular outreach and reduced vaccination sessions. Evidence shows that children in conflict-affected areas are significantly less likely to receive timely vaccinations compared to those in stable communities (Headley et al., 2025)

Mobility and displacement also play a decisive role. Internally displaced persons (IDPs), nomadic groups, and refugees often experience disrupted health services and lack integration into national immunization programs. Nomadic populations, due to seasonal migration patterns, struggle to complete multi-dose vaccines such as DTP. Refugee camps, while sometimes supported by humanitarian services, face overcrowding and resource constraints that reduce uptake (Adhikari et al., 2021)

Urban slums present a paradox. Although geographically close to health facilities, slum populations often encounter barriers such as poverty, overcrowding, and social exclusion. These factors limit awareness and demand, resulting in incomplete vaccination schedules (Patel et al., 2025).

This study focuses on the Far North region of Cameroon, where geographical disparity factors converge to create significant inequities in vaccination coverage. By employing multivariate logistic regression, the analysis examines how community location, conflict exposure, distance from health facilities, displacement status, nomadic lifestyle, refugee camp residence, and urban slum dwelling influence receipt of DTP1 and DTP3 among children aged 12–35 months. The findings aim to inform policymakers and health practitioners about structural barriers to immunization and guide targeted interventions to improve equity in coverage.

## II. METHODS

### ➤ *Study Design and Setting*

This study employed a cross-sectional design conducted in 2025 in Cameroon's Far North region, an area characterized by insecurity, displacement, and limited health infrastructure. The region was selected because of its high burden of "zero-dose" children and the convergence of multiple geographical risk factors.

### ➤ *Study Population*

The study population comprised mothers of children aged 12–35 months. This age group was chosen because it represents the critical window for completing the diphtheria-tetanus-pertussis (DTP) vaccination schedule. Eligible participants were mothers residing in selected communities who provided informed consent.

### ➤ *Sampling and Data Collection*

A multistage sampling strategy was used. Communities were stratified by geographical risk categories: mountainous villages, conflict-affected areas, settlements located more than 10 kilometers from health facilities, internally displaced persons (IDPs), nomadic groups, refugee camps, and urban slums. Within each stratum, households were randomly selected. Data were collected through structured interviews with mothers and verification of vaccination cards where available. Information on child vaccination status (DTP1 and DTP3) and exposure to geographical disparity factors was recorded.

### ➤ *Variables:*

- Dependent variables: Receipt of DTP1 and DTP3 (yes/no).
- Independent variables: Geographical disparity factors including: Mountainous community residence, Conflict-affected area residence, Distance >10 km from health facility, internally displaced status, Nomadic lifestyle, Refugee camp residence Urban slum residence.

### ➤ *Data Analysis*

Data were analyzed using multivariate logistic regression to assess associations between geographical disparity factors and vaccination coverage. Odds ratios (OR), 95% confidence intervals (CI), and p-values were reported. The regression model controlled for potential confounders such as maternal education, household income, and child age. Statistical significance was set at  $p < 0.05$ .

### III. RESULTS

➤ *Descriptive Analysis*

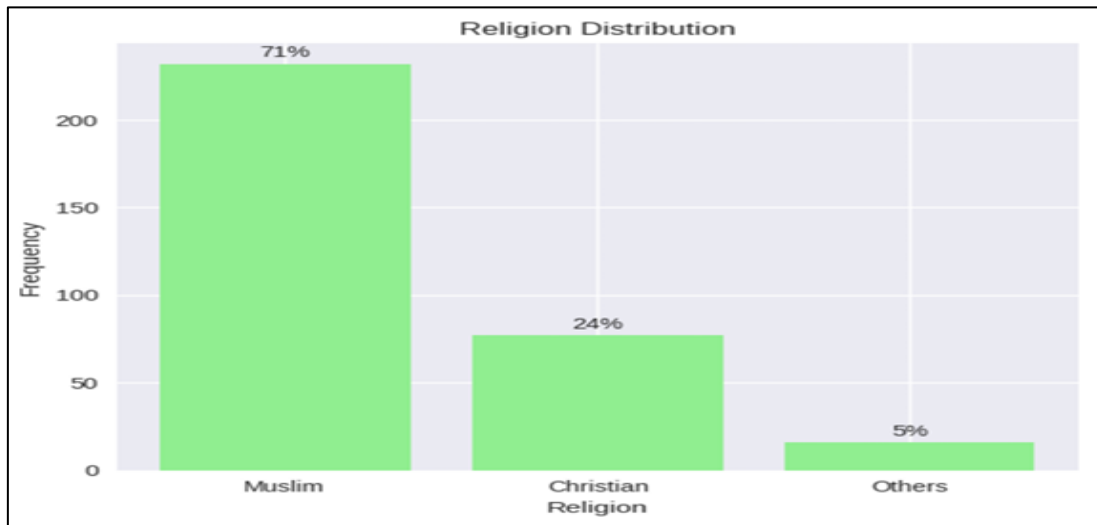


Fig 1 Religion Distribution  
Source: Survey 2025

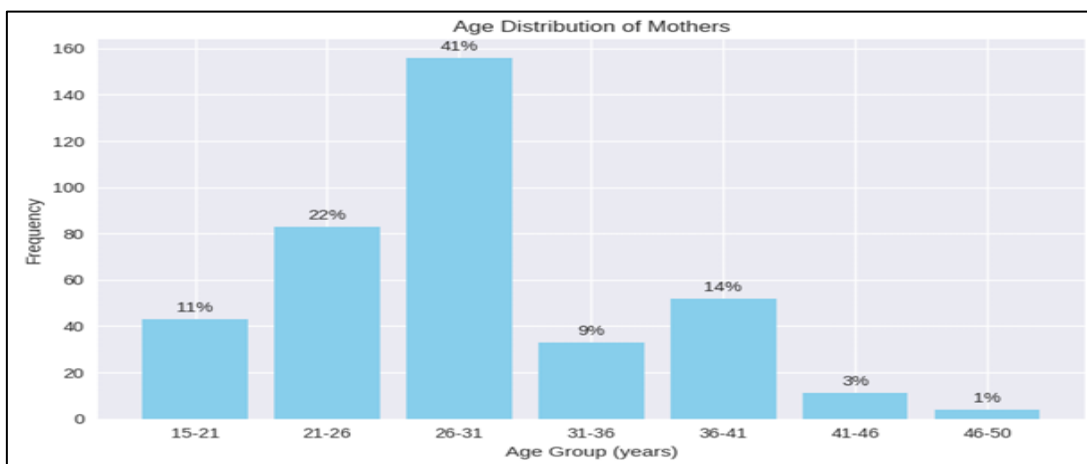


Fig 2 Age Distribution of Mothers  
Source: Survey Data 2025

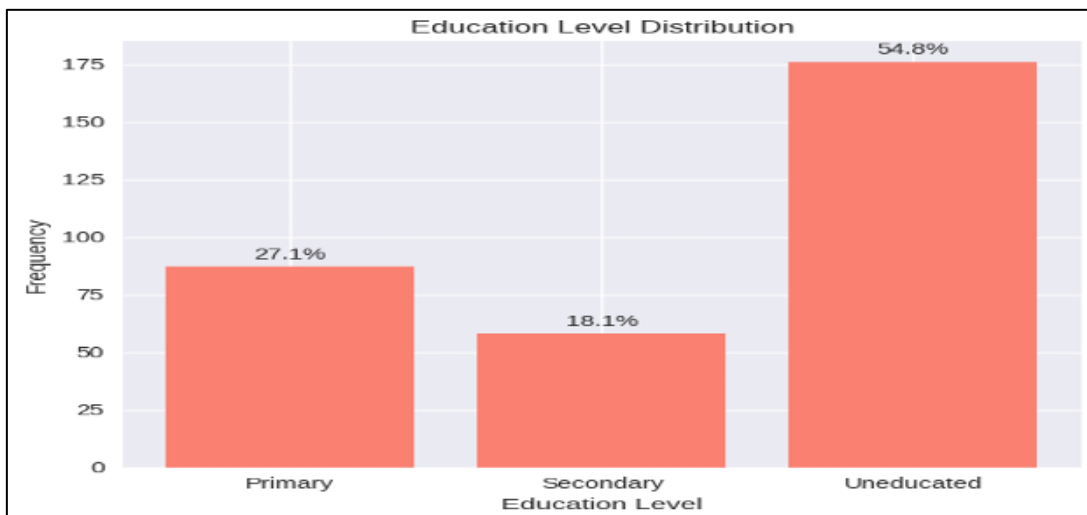


Fig 3 Mothers Education Level Distribution  
Source: Survey Data 2025

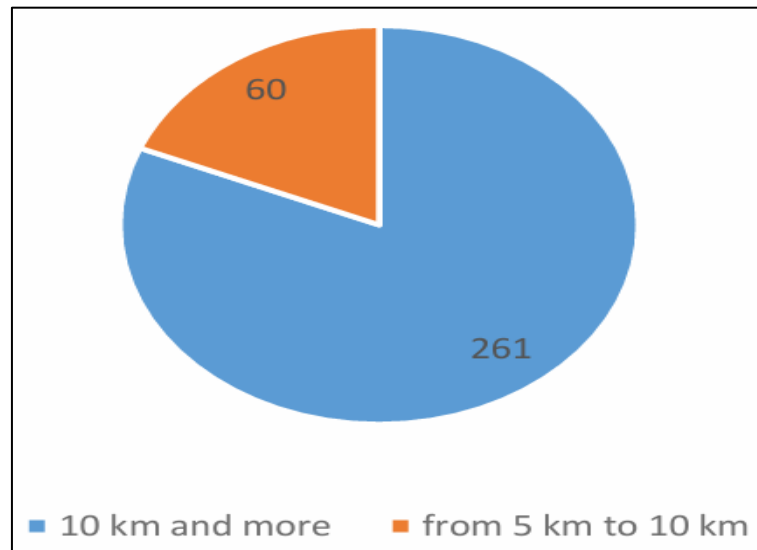


Fig 4 Distance from Health Facilities  
Source: Survey Data 2025

Table 1 Multivariate Logistic Regression Assessing Association Between Geographical Disparity Factors and DTP1

Feature	Odds Ratio	95% CI	p-value
Mountain communities	2.60	0.77–8.71	0.12
Conflict-affected areas	2.07	0.97–4.40	0.06
HF distance (>10 km)	5.11	2.47–10.56	0.001
Internally displaced persons	0.11	0.04–0.36	0.001
Nomads	3.73	1.52–9.17	0.001
Refugee camps	7.69	2.76–21.39	0.001
Urban slums	1.27	0.51–3.18	0.61

Children in refugee camps were 7.7 times more likely to miss DTP1. Distance >10 km increased risk fivefold. Nomadic children were 3.7 times more likely to miss

vaccination. IDPs had significantly lower odds of vaccination.

Table 2 Multivariate Logistic Regression Assessing Association Between Geographical Disparity Factors and DTP3

Feature	Odds Ratio	95% CI	p-value
Mountain communities	2.60	0.77–8.71	0.12
Conflict-affected areas	2.07	0.97–4.40	0.06
HF distance (>10 km)	5.11	2.47–10.56	0.001
Internally displaced persons	0.11	0.04–0.36	0.0002
Nomads	3.73	1.52–9.17	0.004
Refugee camps	7.69	2.76–21.39	0.0001
Urban slums	1.27	0.51–3.18	0.61

Results for DTP3 mirrored DTP1, with refugee camps and distance from health facilities remaining the strongest predictors of missed vaccination.

#### IV. DISCUSSION

This study examined how geographical disparity factors influence vaccination coverage among children aged 12–35 months in Cameroon’s Far North region. The findings reveal that distance from health facilities, nomadic lifestyle, refugee camp residence, and internally displaced status are the strongest predictors of missed vaccination, affecting both initiation (DTP1) and completion (DTP3).

Distance to health facilities emerged as a decisive barrier. Children living more than 10 kilometers away were significantly less likely to receive DTP1 and DTP3. This finding aligns with prior geospatial analyses in Cameroon, which identified physical remoteness as a major determinant of zero-dose (Myemba et al., 2025). The implication is clear: infrastructure development and mobile outreach are essential to reduce inequities in access.

Nomadic populations also showed markedly lower coverage. Seasonal migration disrupts continuity of care, making completion of multi-dose schedules difficult. Similar patterns have been documented in other Sahelian contexts, where nomadic groups remain underserved despite proximity to vaccination campaigns (Afari-Asiedu et al., 2024). Tailored

strategies such as mobile vaccination units and flexible scheduling are needed to reach these mobile communities.

Refugee camp residence was another strong predictor of missed vaccination. Despite the presence of humanitarian services, overcrowding and resource constraints reduce uptake. This highlights the need for better integration of refugee health services into national immunization programs, ensuring continuity and equity for displaced populations (Githaiga et al., 2025)

Internally displaced children faced the lowest odds of vaccination. Displacement disrupts health service delivery and isolates families from routine care. This finding underscores the vulnerability of IDPs, who often fall outside the reach of both national and humanitarian systems.

Internally displaced children faced the lowest odds of vaccination. Displacement disrupts health service delivery and isolates families from routine care. This finding underscores the vulnerability of IDPs, who often fall outside the reach of both national and humanitarian systems (Saidu et al., 2024). Interestingly, mountainous residence and urban slum dwelling were not statistically significant predictors. While terrain and poverty present challenges, they appear less decisive than displacement and distance. Urban slum populations, despite socioeconomic hardship, may benefit from proximity to facilities, partially offsetting barriers (Amani et al., 2023)

## V. POLICY IMPLICATIONS

Addressing geographical disparities requires targeted interventions: expanding mobile vaccination services, strengthening outreach in insecure zones, integrating refugee and IDP populations into national programs, and investing in infrastructure to reduce travel distance. Without such measures, Cameroon's immunization goals will remain unattainable, and vulnerable children will continue to face preventable health risks.

## VI. LIMITATIONS

This includes reliance on maternal recall for some vaccination data and the cross-sectional design, which limits causal inference. Nonetheless, the consistency of associations across DTP1 and DTP3 strengthens confidence in the findings.

## VII. CONCLUSION

This study highlights the critical role of geographical disparities in shaping vaccination coverage among children aged 12–35 months in Cameroon's Far North region. The results show that distance from health facilities, nomadic lifestyle, refugee camp residence, and internally displaced status are the strongest predictors of missed vaccination, affecting both initiation (DTP1) and completion (DTP3). These findings confirm that physical remoteness and displacement are more decisive barriers than terrain or urban poverty alone.

Policy implications are clear: targeted interventions such as mobile vaccination units, outreach tailored to nomadic groups, and integration of refugee and IDP populations into national immunization programs are urgently needed. Investments in infrastructure to reduce travel distance and strengthen service delivery in insecure zones will further help close equity gaps.

Although limited by reliance on maternal recall and cross-sectional design, the consistency of associations across DTP1 and DTP3 strengthens confidence in the findings. Addressing these disparities is essential for reducing zero-dose children, safeguarding child health, and advancing Cameroon's progress toward universal immunization coverage.

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