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FACTORS ASSOCIATED WITH MEASLES INFECTION IN BORDER AND NON-BORDER DISTRICTS OF SIERRA LEONE

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ABSTRACT

Background: Sierra Leone has recorded multiple outbreaks of measles, and the last three outbreaks (2018, 2019, 2022) were reported from point-of-entry communities. Until now, limited information exists on the burden of measles in border and non-border districts. This study aimed to describe the epidemiological trend, vaccination status, incidence, and factors associated with measles infection in border and non-border districts of Sierra Leone.

Methods: We conducted a retrospective secondary data analysis on measles case-based surveillance data from 2018 to 2021 extracted from the national line list and the District Health Information System database. We use the measles standard case definition to classify cases across border districts and non-border districts. Logistic regression was used to identify factors associated with measles infection.

Result: A total of 3,054 suspected measles cases were recorded, of which 1147 (38%) were positive for measles infection with a median age of 9 years (6 months to 37 years). Among the positive cases, 448 (39%) were vaccinated and border districts accounted for 438 (38.1%). The measles incidence in border districts ranges from 3 to 11 per 100,000 population, whilst in non-border districts it ranges from 1 to 3 per 100,000 population.

Conclusion: A high incidence of measles cases were recorded in border districts and the vaccination status among susceptible was low. We recommend intensifying regular and supplemental immunization activities targeting border and non-border districts in Sierra Leone.

Keywords: Measles, Incidence, vaccination, Border and non-border districts, Sierra Leone.

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INTRODUCTION

Measles is an infectious viral disease, that causes morbidity and mortality, especially among young children which remains a public health challenge in developing countries (Li et al., 2020). Every 2-3 years, an outbreak of measles occurs, with an estimated 2.6 million deaths (WHO, 2022). Between 2000 and 2018, the measles vaccine prevented approximately 23.2 million deaths and the global measles infection declined by 73%, from an estimated 536,000 cases to 142,000 cases (WHO, 2022). Despite the progress in measles elimination globally, the infection remains a major public health concern, especially in developing countries such as Sierra Leone (Wariri et al., 2021).

Sierra Leone is a country that shares international boundaries with Guinea in the north and northeast and Liberia in the South and South-East. In 1978, Sierra Leone launched the Expanded Program on Immunization (EPI) to manage the childhood immunization program including measles vaccination (Government of Sierra Leone, 2014). Following the launching of the EPI program and after several routine and supplement vaccination activities, the Measles Containing Vaccine (MCV) increased from 37% in 2000 to 90% in 2022, and MCV two (MCV2) increased from 33% in 2016 to 73% in 2022 respectively (Burton et al., 2012). Despite these increases, Sierra Leone continues to experience multiple measles outbreaks, with the last three outbreaks reported from border communities. These outbreaks occurred in Kambia district in 2018 (Bangalie, 2020), Koinadugu District in 2019 (Crisis24, 2018) and Kambia District in 2023 (Mansaray et al., 2023). The country has 19 cross-border borders and points of entry manned, and 4 of them are designated. An estimated 150 to 200 passengers cross borders daily in Sierra Leone (International Organization for Migration, 2021), and the risk of measles infection is high in border districts (Lanini et al., 2014; Li et al., 2020). According to the Sierra Leone demographic health survey report in 2019, the average annual vaccination coverage rate of children aged 12 to -23 months who received all basic vaccines for border districts was 55.8% compared to non- border districts 57.8% (Statistics Sierra Leone (Stats SL) and ICF, 2019). This low measles vaccination coverage is below the 95% immunization coverage that the WHO recommends (WHO, 2023), which suggests that Sierra Leone is far away from achieving measles elimination soon.

To improve measles elimination efforts in Sierra Leone, it is important to understand the epidemiological distribution and factors associated with measles infection in border and non-border districts. This will inform the implementation of appropriate public health interventions, and policy development and foster progress in cross-

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border coordination with neighbouring countries. This study aimed to describe the epidemiological trend, vaccination status, and risk factors of measles in border and non-border districts of Sierra Leone.

METHODS

Study design

A retrospective secondary data analysis for measles cases was conducted for border and non-border districts of Sierra Leone, between 2018 and 2021.

Study area

This study was conducted in Sierra Leone, which is located on the West Coast of Africa. Sierra Leone is divided into five regions: North, Northwest, South, East, and West, and has sixteen districts. Sierra Leone has a population of 7,541,641 (Sankoh, 2021) and the main capital city is named Freetown. The country has eight border districts: and 8 non-border districts Shown in Figure 1. Border District is defined as districts that directly share international boundaries with Guinea or Liberia (Figure 1). The healthcare system is operated into three levels: primary (at peripheral health units and community), secondary (district hospitals), and tertiary (main referral hospitals, mostly located in Freetown). In total, Sierra Leone has approximately 1,500 health facilities.

Data Collection

We extracted data from the national measles line list and the District Health Information System database. We merged the data, cleaned it, and validated it in Microsoft Excel. Key variables extracted include District, Age, sex, year, vaccination status, and laboratory results, etc. The outcome was positive measles cases, and the independent variables were: vaccination status, age, Sex, District, etc.

Data analysis

We calculated measles vaccination coverage as the proportion of children who received a first or second dose of measles by the target population. We used univariate analysis to report frequencies and proportions. Bivariate analysis was performed to assess the association between the dependent variable and independent variables. Suspected measles cases in border and non-border districts were considered outcome variables. The independent variables included measles infection, vaccination status, age group, and gender. In bivariate analysis, a cut-off of 0.2 of the P-value was used to include variables in multivariate. We used a cut-off of 0.2 p-values to consider a variable as significantly associated with measles cases in border and non-border districts at bivariate analysis. We used Epi Info to calculate the adjusted Odds Ratio (aOR) and 95% confidence interval (CI). Any variable with a p-value less than 0.05 was considered significant in multivariate analysis.

Ethical consideration

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Permission to conduct this study was obtained from the Director of Health Security and Emergencies, Ministry of Health. Presenting the study findings does not expose study participants to any risk. Identifiable participant information will not be disclosed publicly to maintain confidentiality.

RESULTS

A total of 3054 suspected measles cases were recorded in all 16 districts from 2018-2021. Among the suspected cases, 1147 (38%) were positive for measles infection with a median age of 9 years (range: 6 months to 37 years). Among the positive cases, 448 (39%) were vaccinated and border districts accounted for 438 (38.1%). Males accounted for 674 (59%) and it was high among under five males 731 (63.7%). The highest measles incidence was recorded in Kailahun, Kono, and Koinadugu districts ranging from 6 to 11 per 100, 000 Population (Figure 2).

Annually, the incidence rate of measles in border districts was high in 2018 and 2020 which was 5 and 4 per 100,000 populations respectively, while non-border districts, recorded 1 per 100,00 populations from 2019-2021 respectively (Figure 3). The vaccination status of the measles cases in border districts was 38% for fully vaccinated and 54% for not vaccinated while in non-border districts 62% for fully vaccinated and 46% for not vaccinated (Figure 4). The proportion of measles cases recorded for males was 54% in the border district and 58% for males in non-border districts (Figure 5). Seventy-eight percent (895/1147) of the measles cases were reported in under-five children and 22% (252/1147) of the measles cases were reported among above five age group.

Table 1 shows individuals residing in district border districts had 1.6 times the odds of getting measles infection as compared to non-border districts and it was statistically significant at multi-variate level (aOR=1.6; 96% CI: 1.34, 1.97). Those who were vaccinated had 0.4 odds to be reported from border districts and it was statistically significant and the multivariate level (aOR= 0.4; 95% CI: 0.35, 0.61). Under five years suspected cases of measles infection had 16.2 odds of being reported from border districts as compared to those above five years was statistically significant and the multivariate level (aOR=16.2; 95% CI: 13.55, 20.34). Female measles-suspected cases had 0.3 times the odds of being reported from border districts and the difference was statistically significant at multivariate level (aOR= 0.3; 95%CI: 0.35, 0.61).

DISCUSSIONS

To the knowledge of the authors, this is the first study that compared the incidence of measles, its vaccination coverage rates and risk factors in border and non-border districts of Sierra Leone. In this study, we found a high measles incidence among children residing in border districts,

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especially in Koinadugu, Kono, and Kailahun districts sharing international boundaries with Guinea. The highest measles incidence was recorded in 2018 followed by 2020. The majority of children residing in border districts were not vaccinated compared with non-border districts. Regarding factors associated with measles infection in border districts: people aged five years and above, being male, and not vaccinated for measles were factors associated with measles infection.

Several factors could be attributed to border districts recording the highest incidence of measles. In Sierra Leone, border districts are characterized by remoteness, limited healthcare workers, limited information on healthcare-seeking and medical equipment, and frequent movement of people across border points without medical checks (International Organization for Migration, 2021). These factors combined could have affected measles vaccination service delivery and uptake resulting in the high incidence of measles in border districts compare to non-border districts. This finding is similar to a study conducted in Nigeria where the authors reported communities that links to other states (border communities) and those in rural states contributing the highest burden of measles infection than the urban settlements (Shorunke et al., 2019). The authors suggested low vaccination coverage and low compliance of measles vaccination for the high measles incidence in these states. Nigeria and Sierra Leone share similar geographical features and healthcare system operations.

Our study also found a peak of measles incidence in 2018 followed by 2020 in border districts. The peak of measles incidence in 2018 could be attributed to the prolonged consequences of the 2014-2016 Ebola outbreak in the country (CDC, 2020). During the Ebola outbreak, healthcare services were disrupted and children residing in the extreme districts, mostly border districts, were not able to get routine measles vaccines. Similarly, the measles incidence peak in 2020 could be attributed to the COVID-19 pandemic, which was declared in March 2020 in Sierra Leone (World Health Organization, 2021). Like in the Ebola outbreak (CDC, 2020), the COVID-19 pandemic disrupted the healthcare services including measles vaccination, consequently affecting the uptake of measles vaccines, especially for children residing in border districts. A study conducted in Kambia district in 2018 (Bangalie, 2020) and 2023 (Mansaray et al., 2023), and Koinadugu district in 2018 (CRISIS24, 2018), both border districts reported measles outbreak due to disruption in measles vaccination services during Ebola and COVID-19.

Even though our study found that majority of people residing in border districts were unvaccinated compared with non-border border districts the proportion of fully vaccinated people in border (38%) and

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non-border districts (62%) were less than the Expanded Program of Immunization targets of 95% in Sierra Leone (Government of Sierra Leone, 2014). This put large proportion of the population at risk of developing measles infection. Vaccination is a critical component for preventing measles - with two doses recommended for administration at 9 months and 15 months respectively (WHO, 2023). In Sierra Leone, the health system factors including limited measles vaccine and human resource couple with socio-economic factors and cultural beliefs triggered by the civil war, Ebola, and COVID-19 pandemic could have contributed to the low vaccination coverage (Senessie, Gage and von Elm, 2007; Masresha et al., 2020).

Implications of study findings

Because Sierra Leone is challenged in providing swift healthcare services, the high measles incidence especially in border districts, and the low proportion of fully immunized people suggest a potential measles outbreak if prompt measures are not taken. These outbreaks will result in high morbidity and mortality, further deterring the progress made in measles elimination. To lower the risk of measles infection, it is necessary to enhance cross- border interventions including regular cross-border meetings among stakeholders in neighboring countries, especially in Guinea, and intensify routine and supplemental immunization in Sierra Leone. It is worth mentioning that a lot of effort was made to have an effective measles vaccine. However, if these vaccines cannot get to all the children who need them, measles outbreaks and death from measles cannot end

Limitations of study

This study has certain limitations. First, this study used secondary data that did not capture the mortality of measles cases, making it difficult to calculate some key indicators including case fatality rate. Additionally, this is a cross-sectional secondary data analysis study, which cannot establish a causal association between the outcome and independent variables.

Conclusion

This study showed a high incidence of measles infection in border districts with districts bordering Guinea recording higher measles incidence than those bordering Liberia. Vaccination coverage across both border and non-border districts was poor. People aged five years and above, being male, and not vaccinated for measles infection were factors associated with measles infection. We recommend implementing supplemental immunization activities targeting border districts.

Competing interest

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- The authors declare no competing interest.

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Annexes

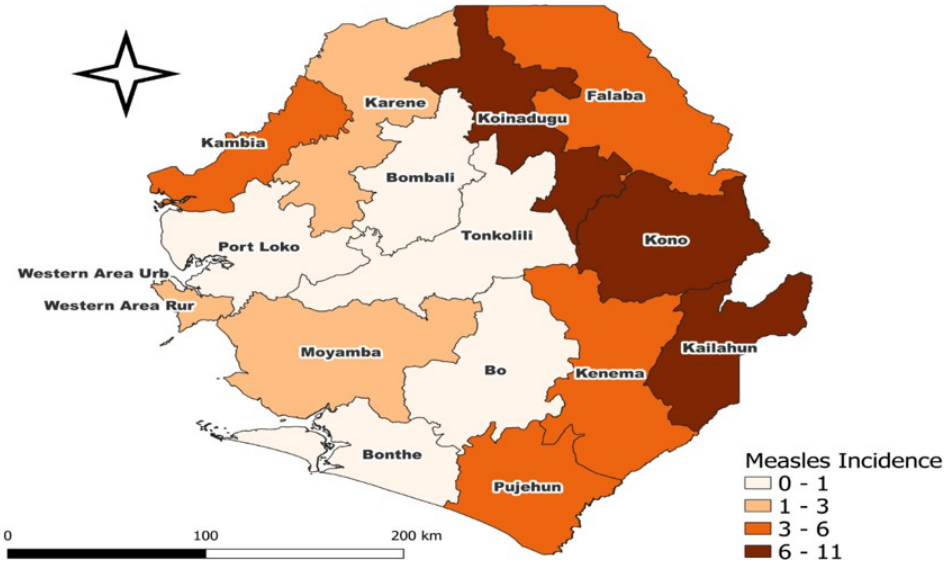

Figure 1: Incidence rate per 100,000 population of measles in border and non-border districts in Sierra Leone, 2018-2021

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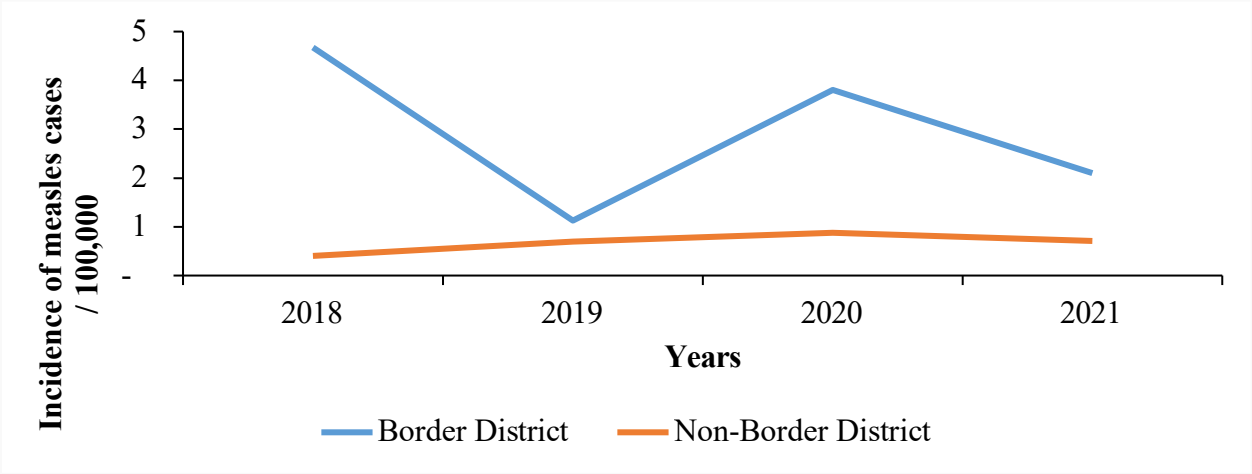

Figure 2: Incidence rate per 100,000 population of measles in border and non-border districts by year in Sierra Leone, 2018-2021

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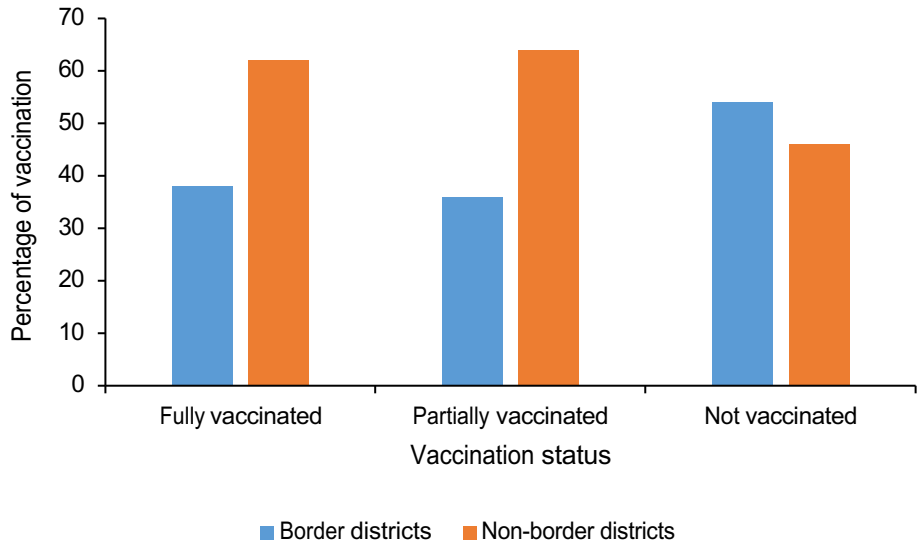

Figure 3: Vaccination status of measles cases stratified by border and non-border district, Sierra Leone, 2018-2021

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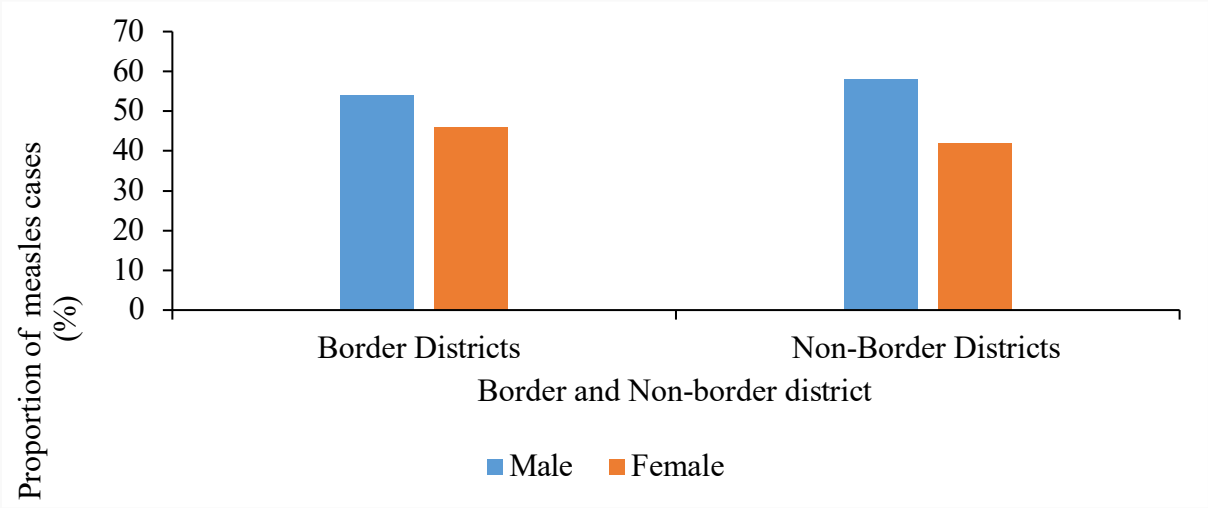

Figure 4: Proportion of Measles cases by sex, stratified border and non-border districts, Sierra Leone 2018-2020

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Table 1: Bivariate and multivariate analysis of the factors associated with the suspected measles cases by border and non-border districts

Variables	Suspected measles cases in non-Border district	Suspected measles cases in Border district	cOR (95% CI)	P-Value	aOR (95% CI)	P-Value
Gender						
Male	783	968	1		1	
Female	445	858	1.3 (1.15, 1.56)	<0.001*	0.3 (0.35, 0.61)	<0.001*
Age group						
Less than five	1555	640	1		1	
Five and above	196	843	1.8 (1.53, 2.04)	<0.001*	16.6 (13.55, 20.34)	<0.001*
Measles infection						
Negative	709	438	1		1	
Positive	1042	865	1.3 (1.15, 1.56)	<0.001*	1.6 (1.34, 1.97)	<0.001*
Vaccination						
Not Vaccinated	596	707	1		1	
Vaccinated	1048	703	1.8 (1.53-2.04)	<0.001*	0.4 (0.35, 0.61)	<0.001*