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Factors Associated with Measles Occurrence Among Children 0-5 years in Health Facilities in Gombe State

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Abstract

Introduction:

Measles remains a significant public health concern among children in Nigeria, particularly in Gombe State. This vaccine-preventable disease poses a substantial threat to the health and well-being of children aged 0-5 years. In light of this, our study aimed to investigate the factors associated with Measles occurrence in this vulnerable age group.

Methods:

A case-control design was employed to assess the factors contributing to Measles occurrence among children aged 0-5 years in Gombe State, Nigeria. Data collection involved the administration of a structured questionnaire to both cases and controls, and SPSS version 23.0 was utilized for data analysis.

Results:

The analysis revealed a strong association between risk factors and Measles occurrence, with malnutrition emerging as a significant risk factor, increasing the likelihood of Measles infection by 24 times in malnourished children compared to their healthy counterparts. The mean age of the children was 3.09 years (SD±0.152 years). However, there was no significant relationship between Measles prevalence and its occurrence among children aged 0-5 years. Furthermore, the study highlighted the co-relationship between risk factors and predisposing factors, emphasizing the importance of data quality in understanding Measles outbreaks. Additionally, it was found that the educational level of parents did not significantly influence Measles occurrence in this age group.

Conclusion:

This study underscores the need for comprehensive vaccination programs, improved data quality, and effective public health education campaigns to reduce Measles incidence among children aged 0-5 years in Gombe State, Nigeria. These findings can inform targeted interventions and collaborative efforts among healthcare providers, governmental agencies, and communities to enhance Measles prevention and control strategies, ultimately safeguarding the health of the pediatric population.

Keywords: Measles, Children, Gombe State, Case-Control Study, Malnutrition

Introduction

According to World Health Organization (2023) Measles is an infectious viral disease caused by the Morbillivirus, a member of the Paramyxovirus family. It is transmitted to susceptible individuals through aerosol or direct contact (WHO, 2023). The viral pathogen infiltrates the mucosal linings of an individual who has been exposed, subsequently disseminating to various anatomical regions. According to Akande (2007) [5], it is widely recognized that measles exclusively affects humans and does not have any known animal reservoir. The measles virus is an effective pathogen that exhibits persistence within a population of sufficient size to sustain its transmission, despite inducing acute infection in an individual only once during their lifetime (Zuckerman et al., 2009). Measles, a disease with a long historical record, became amenable to experimentation only after the successful isolation of the virus by Enders and Peebles in 1954 (Zuckerman et al., 2009).

According to Ibrahim *et al.* (2019) [32], the initial manifestation of infection typically presents as a heightened body temperature, commonly referred to as high fever. This symptom typically emerges within a time frame of approximately 10 to 12 days subsequent to exposure and persists for a duration ranging from one to seven days. During the initial phase, individuals

may exhibit symptoms such as nasal discharge, coughing, ocular irritation characterised by redness and excessive tearing, as well as the presence of small white lesions on the inner lining of the cheeks. According to the World Health Organisation (2007), a rash typically manifests approximately 14 days following viral exposure, with a variation in the incubation period ranging from 7 to 18 days. This rash primarily emerges on the face and upper neck, gradually extending to the hands and feet. Its duration spans approximately five to six days before gradually diminishing.
Unfortunately, most measles morbidity and mortality are mostly seen in under-five children (WHO, 2017) [67]. Nigeria is one of only ten countries in the world with measles vaccine coverage of less than 50% (Schimmer, 2006). Nigeria is among the 45 countries that account for 94% of the deaths due to measles worldwide (WHO, 2017) [67]. There are few literatures in Nigeria on the population-based prevalence of measles. However, some studies from tertiary hospitals showed the proportion of measles from pediatric admissions stands at between 1.3-5.1% (Onyiriuka, 2011). Furthermore, the reported CFRs for measles in Nigeria showed regional variations ranging from 1.9% to 12.4% (Ogunmekan, 1981) [47]. An epidemiologically study conducted by BaffaSule describe measles infection in Nigeria and highlight the burden of the disease in the country. The study found a high burden of measles especially in the northern part of Nigeria which include Gombe State recording cases fatality rate (CFR) of 0.25%. Measles attack rates in Nigeria from this study showed to be more in the northern regions, with several States from these regions severely affected than the southern States. These findings are in tune with findings from several studies that have opined measles infection to be concentrated in the northern region of Nigeria (WHO, 2018) [68]. Measles attack rates were higher in the Northern States of Nigeria, with Katsina, Sokoto and Yobe, recording more than 200 cases per 100,000 population. While Kebbi and Bauchi recorded between 150 - 199 cases per 100,000 population. Most States in the southern regions recorded low attack rates for measles during the same period, with only Ekiti State recording between 50-99 cases per 100,000 population. Conversely, the measles cases facility rate (CFR) per States showed a different picture. Though more States from the northern region had higher cases facility rate (CFR), two states from the southern region (Ebonyi and Rivers States) recorded the highest cases facility rate (CFR) (above 4.99%). Also, Katsina, Kaduna, Bauchi and Gombe States, all from the northern region, recorded cases facility rate (CFR) of less than 0.25%. The purpose of this study is to determine factors associated with Measles occurrence among children 0-5 years in Gombe State.

Materials and Methods

Study Design

A case control research design was adopted for this study. Case-control (retrospective) study design is applied in analytic epidemiology to establish a relationship between risk factor and exposure, when two distinct population groups are being compared, the findings provide sufficient evidence to direct prompt and effective public health control and prevention measures (Abanobi, 2010). This research was carried out using retrospective case control study. A 1:1 matched case control study was conducted between cases and controls.

Case definitions

Probable case was defined as onset of fever and generalized maculopapular rash with at least one of the following symptoms: Coryza, conjunctivitis, or cough.
A confirmed case was a probable case with serum positivity of measles-specific IgM antibody. The case definition was developed after reviewing the clinical presentations of some of the measles patients and discussing with clinicians.

Case finding

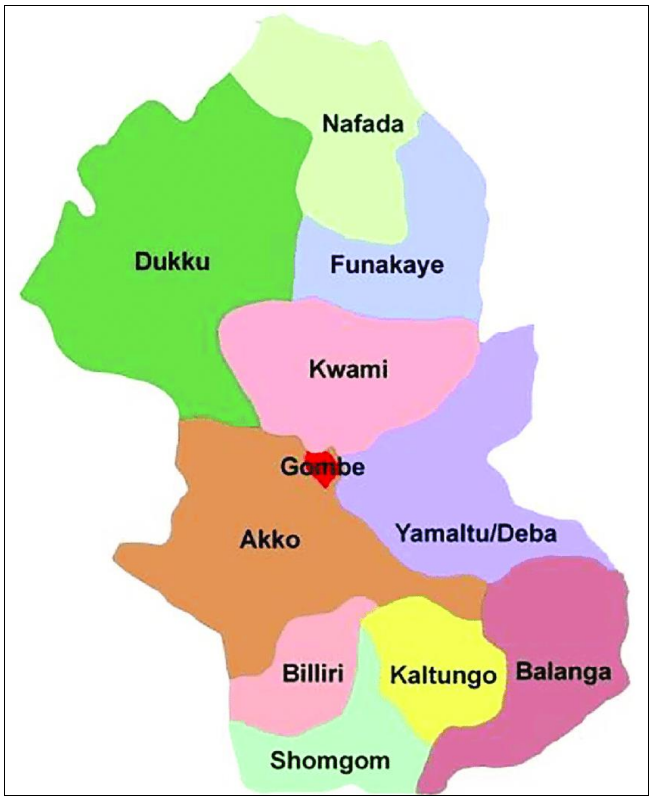
Systematic case finding was done by visiting State health facility (Hinna Cottage State Hospital, Gombe). The patient records from 1 January 2019 to June 2020 was reviewed to identify probable and confirmed cases based on the case definition. The records in the Health facility already had basic information for each patient, including name, age, sex, residence, admission date, and symptoms. Health workers was trained on case finding using the case definition. Case-patients' homes was visited to verify the cases.

Control Findings

A 1:1 matched case-control study was done to evaluate the potential exposures that emerged during hypothesis generation. The control group consisted of healthy children with no history of febrile rash. These children served as the comparison group to understand the differences in various factors between them and the cases (children diagnosed with measles). Parents of the selected control children gave oral informed consent for their participation in the study.

Area of Study

Gombe State was the area of study for this research. Gombe, usually referred to as Gombe State to distinguish it from its capital city Gombe, is located in northeastern Nigeria and is one of the country's 36 states. The boundaries of the state roughly correspond to those of the Tangale-Waja Chiefdom and Gombe Emirate, a traditional state. The state is chiefly inhabited by indigenous tribes which Fulani constitute the majority amongst the indigenous tribes and other minority tribes. The state has an area of 20,265 km² and a population of around3,256,962 (NPC, 2016). The State's slogan is the Jewel In The Savannah. It was formed in October 1996 from part of the old Bauchi State by the Abacha military government. Its location in the north eastern zone, right within the expansive savannah, allows the state to share common borders with the states of Borno, Yobe, Taraba, Adamawa and Bauchi. Gombe has two distinct climates, the dry season (November–March) and the rainy season (April–October) with an average rainfall of 850mm.



Source: Maryam Al-Mujtaba (2020)

Fig 1: Map of Gombe state showing the 11 Local Government Areas.

Study Population

The target population for this study were children between the ages of 0-5 years. Children are most affected by measles, they are more susceptible to the disease because of their age. The target audience were the mothers of the children, since the information was not to be collected through the children because of their age. Information was given about the children by the mothers.

Sample Size Determination

In case control studies, cases (the group with disease/condition under consideration) are compared with controls (the group without disease/condition) regarding exposure to the risk under question.

This research is a qualitative variable, thus the sample size formula as describe by Patra, 2011.

$$\text{Sample Size} = \frac{r + 1(p^*)(1-p^*)(Z_\beta + Z_{\alpha/2})^2}{r \quad (P_1 - P_2)^2}$$

r = Ratio of control to cases, 1 for equal number of case and control

p* = Average proportion exposed = proportion of exposed cases + proportion of control exposed/2

Z_β = Standard normal variate for power = for 80% power it is 0.84 and for 90% value is 1.28. Researcher has to select power for the study.

$Z_{\alpha/2}$ = Standard normal variate for level of significance

$P_1 - P_2$= Effect size or different in proportion expected based on previous studies. P_1 is proportion in cases and P_2 is proportion in control.

Therefore,

r = 1

p* = Average proportion exposed = proportion of exposed cases + proportion of control exposed/2

= (0.35-0.20)/2

p* = 0.275 0.225

Z_β = Standard normal variate for power = for 80% power it is 0.84

$Z_{\alpha/2}$ = 1.96

$P_1 - P_2$= $(0.35-0.20)^2$ = 0.0225 0.0025

$$\text{Sample Size} = \frac{1 + 1(0.275)(1-0.275)(0.84+ 1.96)^2}{1 \quad 0.0225}$$

N = 138

Sampling Techniques

Probability Sampling Method (Simple Random Sampling) techniques was employed to select the cases from the probable cases, and also their corresponding controls. In this case each individual is chosen entirely by chance and each member of the population has an equal chance, or probability, of being selected. Balloting system was used to select the number of samples from the entire number.

Instrument of Data Collection

A self-designed structured questionnaire was used to collect data on demographic characteristics (age, sex, and education level), exposures, and vaccination status and associated factors from both cases and controls, and clinical information from them.

Validity of Instrument and its Reliability

Content Related Evidence (Face validity) was used for instrument validation. It was noted that selected and recruited cases were consecutively from among the patients that presented at the health facility and in the community. It was reviewed by two expert epidemiologist and a researcher in the field of public health. The reliability of this study was posed on the basis of an adopted instrument for this study. This instrument was used in a study by Nsubuga *et al*., (2018) [45] to determine the factors contributing to transmission of Measles in western Uganda. Also, Wikidan *et al.,* (2021) used this same instrument to determine the risk factors of Measles outbreak among students in South West Ethopia.

Method of Data collection and Analysis

Standard method of Data collection was employed in this study. After obtaining informed consent, the eligible subjects was interviewed in person by well-trained investigators using a questionnaire. The Pearson chi-square test of SPSS version 23.0 (statistical package) was used to analyze the data obtained from questionnaires and the hospitals, and this was used to determine the relationships between risk factors and measles occurrence, prevalence of Measles, the predisposing factors and the parental knowledge of vaccine, P value < 0.05 significant at 95% confidence interval, and results obtained was presented in tables.

Ethical Consideration

Ethical assurance was obtained from Gombe State Ministry of Health. This is in line with the International Guidelines for Ethical Review of Epidemiological Studies by the

Council for International Organization of Medical Sciences (1991). Verbal informed consent was obtained from the mothers of the children involved in the study and purpose of the study explained to them.

Results

A total sample of 138 children were identified, out of which 120 (40 measles cases and 80 controls), were included in the study making an 86.9% response rate. From the total 16 (40%) of the cases and 22 (27.5%) of the controls were female children. The mean ages of cases were 2.6±1.25 SD years while the mean age of controls were 2.8±1.005 SD years.

Socio-demographic characteristics of the respondents

From Table 1 below, a total of 40 measles cases, with no deaths, were reported during the investigation. An index male case was a 3 years old, who presented with sudden onset of rash, cough, fever and conjunctivitis. He had a travel history to meet his family, where a measles outbreak occurred before, three weeks ago, among children. All of the five specimens that were collected from the 40 cases reported on the line list were measles IgM positive. The mean age of the children was 3.09 years (SD±0.152 years). Among all measles cases the majority 60% (24) were males.

Table 1: Socio-demographic characteristics of the respondents

Variables	Cases N = 40	Controls N = 80	COR in 95% CI	P-value
Sex				
Female	16(40%)	22(27.5%)	1	0.167
Male	24(60%)	58(725%)	1.758(0.255,1.267)	
Age				
0-3	19(47.5%)	66(82.5%)	1	0.000*
4-5	21(52.5%)	14(17.5%)	0.192(0.82,0.448)	
Religion				
Muslim	4(10%)	11(13.8%)		
Orthodox	31(77.5%)	47(58.8%)		
Protestant	5(12.5%)	20(25%)		
Others	0(0.0%)	2(2.5%)		

Note: *P<0.05. COR, crude odds ratio.

From the symptom onset date of the index case-person (November 5, 2019) to that of the last case-person (29 November, 2019), the outbreak lasted 25 days. Measles transmission from the index case to other children occurred in the health care facility (Fig 2).

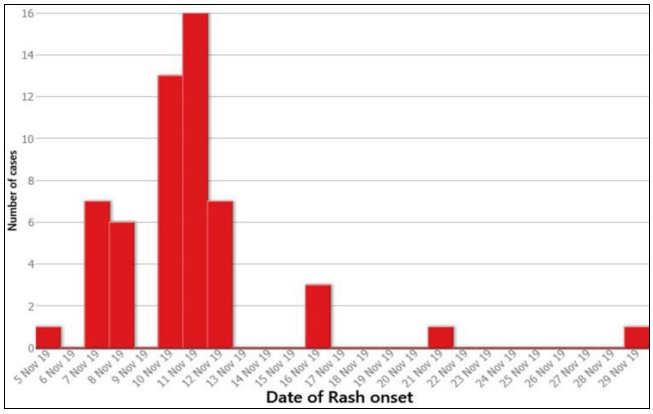


Fig 2: Measles cases reported by date of onset among children 0-5 years in a health facility in Gombe, Gombe State

Bivariate Analysis for Different Exposure of Measles Outbreak among children 0-5 years in a health facility in Gombe, Gombe State

The majority of the children, 18 (45%) and 65 (81.2%), among cases and controls had vaccination history respectively. By contrast, 22 (55%) cases and 15 (18.8%) controls had never been vaccinated. On the other hand 30 (75%) cases and 72 (90%) controls had no contact history with infected measles patients. Regarding the knowledge level of the parents/caregivers of the children about measles infection 15 (37.5%) cases and 20 (25%) controls had poor knowledge about measles infection. Similarly, 13 (32.5%) of the cases and 12 (15%) controls described the presence of a measles infected children within the health facility.

Table 2: Bivariate Analysis for Different Exposure of Measles Outbreak among children 0-5 years in a health facility in Gombe, Gombe State

Variables	Cases N = 40	Controls N = 80	COR in 95% CI	P-value
Vaccination status				
Not vaccinated	22(55%)	15(18.8%)	1	0.000*
Vaccinated	18(45%)	65(81.2%)	5.29 (2.29,12.251)	
Contact history				
No	30(75%)	72(90%)	1	0.035*
Yes	10(25%)	8(10%)	0.33(0.120,0.927)	
Knowledge of Parents/Caregivers				
Poor knowledge	15(37.5%)	20(25%)	1	0.158
Good knowledge	25(62.5%)	60(75%)	1.8(0.796,4.071)	
Infected person in the Health Center				
No	27(67.5%)	68(85%)	1	
Yes	13(32.5%)	12(15%)	0.367(0.149,0.904)	0.029*
No. of children in the health center				
≤ 4	5(12.5%)	15(18.8%)	1	
5–7	26(65.5%)	62(77.5%)	0.795(0.262,2.414)	0.685
≥8	9(22.5%)	3(3.8%)	0.777(0.021,1.110)	0.991
Previous measles infection				
No	34(85%)	74(92.5%)	1	
Yes	6(15%)	6(7.5%)	0.459(0.138,1.529)	0.205

Note: *P<0.05. COR, crude odds ratio

Multivariate Analysis of Predictors of Measles Outbreak, among children 0-5 years in a health facility in Gombe, Gombe State

In multi variable logistic regression analysis (Table 3 below), age, sex, contact history and vaccination status were independently associated with the measles outbreak. children in the age group of 0-3 years were 87.5% less likely to have a measles infection than those who were 4-5 years [AOR = 0.123, 95% CI (0.041, 0.37)]. Another factor that showed an association of measles infection was the sex of the children. Female children were 4 times more likely to develop measles infection than male children [AOR = 4.21, 95% CI (1.426, 11.182)]. Having a history of contact with an infected student was also independently associated with the outbreak [AOR = 0.149, 95% CI (0.041, 0.544)]. The other strong predictor of measles infection was vaccination status, recording an odds ratio of 5.21 (95% CI (1.938, 12.058)), which indicates un-vaccinated children were almost 5 times more likely to have a measles infection than vaccinated children.

Table 3: Multivariate Analysis of Predictors of Measles Outbreak, among children 0-5 years in a health facility in Gombe, Gombe State

Variables	Cases (N = 40)	Controls (N = 80)	COR in 95% CI	AOR in 95% CI	P-value
Vaccination status					
Not vaccinated	22(55%)	15(18.8%)	1	1	
Vaccinated	18(45%)	65(81.2%)	5.29 (2.29,12.251)	5.149(1.938,12.058)	0.001*
Infected person in the health facility					
No	27(67.5%)	68(85%)	1	1	
Yes	13(32.5%)	12(15%)	0.367(0.149,0.904)	0.591(0.156,2.234)	0.438
Knowledge of parents/care givers					
Poor knowledge	15(37.5%)	20(25%)	1	1	
Good knowledge	25(62.5%)	60(75%)	1.8(0.796,4.071)	2.033(0.683,6.050)	0.202
Contact history					
No	30(75%)	72(90%)	1	1	
Yes	10(25%)	8(10%)	0.33(0.120,0.927)	0.149(0.041,0.544)	0.004*
Previous measles infection					
No	34(85%)	74(92.5%)	1	1	
Yes	6(15%)	6(7.5%)	0.459(0.138,1.529)	0.348(0.074,1.644)	0.183
Sex					
Female	16(40%)	22(27.5%)	1	1	
Male	24(60%)	58(725%)	1.758(0.255,1.267)	4.21(1.426,11.182)	0.009*
Age					
0–3	19(47.5%)	66(82.5%)	1	1	
4–5	21(52.5%)	14(17.5%)	0.192(0.82,0.448)	0.123(0.041,0.370)	0.000*

Note: *P<0.05. COR, crude odds ratio; AOR, adjusted odds ratio.

Discussion

The primary aim of this case-control study was to ascertain the factors that are linked to the occurrence of Measles among children within the age range of 0-5 years in Gombe State. The examination of results yielded a statistically significant correlation between risk factors and the incidence of Measles within this particular age cohort. The estimated value of 0.001 and a likelihood ratio of 1.00 suggest a robust correlation between these risk factors and the occurrence of Measles infection. This study revealed a significant association between malnutrition and Measles infection, indicating that malnourished children face a substantially elevated risk of contracting Measles, approximately 24 times higher than their well-nourished counterparts. The aforementioned results are consistent with prior investigations carried out in Bayelsa State (Ayele, 2016) and are in contrast to other studies conducted in the identical area (Kalil, et al., 2020).

Moreover, the present analysis of hypothesis two has revealed that there exists no discernible correlation between the prevalence of Measles and its incidence among children within the age range of 0-5 years. The aforementioned discovery aligns with data derived from previous research, which indicates that Measles predominantly impacts young children who have not received vaccination (Ma, Hao, and Zhang 2014). Nevertheless, it is crucial to acknowledge that the association between the prevalence and occurrence of Measles is complex and influenced by a multitude of factors, one of which is the rate of vaccination.

Furthermore, the findings of this study indicate a significant correlation between risk factors and predisposing factors in the occurrence of Measles. This finding aligns with the data obtained from previous studies, which have also emphasised concerns regarding data quality, specifically pertaining to the absence of age information and the unknown vaccination status of individuals affected by Measles. The presence of data quality issues has the potential to hinder the promptness of investigations and the comprehensiveness of case investigation forms, thereby influencing our comprehension of the factors that contribute to Measles outbreaks.

Nevertheless, it is crucial to underscore that there exists no substantial correlation between the educational attainment of parents and the prevalence of Measles among children aged 0-5 years in Gombe State. The analysis of hypothesis three, which has a predicted value of 0.224 and a likelihood ratio of 0.664, provides support for this conclusion. This discovery is consistent with epidemiological research that has demonstrated the lack of a substantial association between the educational attainment of parents, specifically both fathers and mothers, and the risk of Measles infection. The findings of our study align with the results of a study conducted in Gambia (Sitepu, et al., 2020), while exhibiting disparities with the research conducted in Iran (Izadi, Zahraie, and Sartipi, 2012).

In order to provide a more comprehensive understanding of these findings, it is imperative to take into account supplementary factors. For example, the vaccination history of individuals has a notable impact, as a significant proportion of children in the control group possess documented records of vaccination. This observation suggests the efficacy of vaccination initiatives in mitigating the occurrence of Measles. Nevertheless, a significant proportion of cases had not received vaccination, underscoring the significance of enhancing vaccination rates in order to mitigate the occurrence of Measles.

Furthermore, the assessment of contact history with individuals infected with Measles and the level of knowledge possessed by parents or carers regarding Measles infection are crucial components in the prevention of Measles. The findings of this study indicate that a significant proportion of cases did not have any documented contact with individuals who were confirmed to be infected, implying potential deficiencies in the processes of contact tracing and surveillance. Furthermore, a substantial portion of both the cases and controls exhibited limited understanding regarding Measles infection, underscoring the necessity for public health initiatives aimed at enhancing knowledge and promoting awareness regarding Measles prevention and vaccination. This research study offers significant contributions in understanding the factors that are

linked to the occurrence of Measles among children within the age group of 0-5 years in Gombe State. Our study revealed a significant correlation between risk factors, specifically malnutrition, and the occurrence of Measles infection. However, our analysis indicates that the prevalence of Measles is predominantly influenced by factors such as vaccination status, contact history, and parental knowledge. The aforementioned results highlight the significance of implementing vaccination programmes, contact tracing efforts, and public health education initiatives as effective measures to decrease the occurrence of Measles within the region.

Conclusions

Measles infection occurred all-year round with increased cases in the 4th quarter of the year and with children less than 0-5 years being more affected. This case-control study carried out in Gombe State provides insights into the complex determinants impacting the occurrence of Measles among children aged 0-5 years. This study has demonstrated a strong correlation between risk factors, specifically malnutrition, and the incidence of Measles infection. However, it is important to note that the prevalence of Measles is primarily influenced by factors such as vaccination status, contact with infected individuals, and the level of parental knowledge. These observations highlight the significant importance of implementing efficient vaccination programmes, enhancing contact tracing efforts, and conducting comprehensive public health education campaigns in order to decrease the occurrence of Measles in the region. There is a clear need for a coordinated endeavour to achieve optimal vaccination rates, increase knowledge regarding Measles prevention, and resolve concerns regarding the accuracy of data in order to comprehensively comprehend and manage Measles outbreaks. Ultimately, these actions are crucial for protecting the well-being of the susceptible paediatric population in Gombe State.

Recommendations

Several recommendations can be made based on the findings of this study on Measles occurrence among children aged 0-5 years in Gombe State to reduce Measles incidence and improve overall public health in the region. Strengthen and expand vaccination programmes in Gombe State, with a particular emphasis on reaching unvaccinated children. Efforts should be made to make vaccines available and accessible to all communities. Furthermore, health officials should consider catch-up vaccination campaigns for children who have missed routine vaccinations.

Increase Contact Tracing: Invest in strong contact tracing and surveillance systems to quickly identify and isolate Measles cases. This will aid in Measles control efforts by preventing further transmission within the community. Strengthen disease surveillance systems to ensure that suspected Measles cases are reported promptly, thoroughly investigated, and responded to in a timely manner. This will aid in the prevention of Measles outbreaks and lessen the impact on the paediatric population.

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