


Received: 18th July, 2025
<https://doi.org/10.47430/ujmr.25102.009>
Accepted: 12th December, 2025

Seroprevalence and Associated Risks of Measles Infection in Children (0-18 Months) Presenting with High Fever in North-Central Nigeria

Ajang, A. Y. *¹ , Babayo, A. M.¹, Cifrat, N. A.¹, David, S. A.¹, Dapiya, H. S.¹, Zakari, H.¹, Davou, V. K.¹, Azi, H. Y.¹, Nkup, J.¹, Katnap, R. S.¹ Amapu, T. Y.², Longwap, A. S.³, Panwul, J. D.⁴ and Yakubu, A.⁵.

¹Department of Microbiology, Faculty of Natural Sciences, University of Jos, Nigeria ²Department of Science Laboratory Technology, University of Jos, Nigeria

³Department of Chemical Pathology, Jos University Teaching Hospital, Jos, Nigeria ⁴Department of Microbiology, Plateau State University, Bokokos, Nigeria

⁵Department of Applied Biology/Microbiology, School of Applied Sciences, Federal Polytechnic Nassarawa, Nigeria

*Corresponding author: yakubuabubakar92@yahoo.com; Tel: +2348065489043

Abstract

Measles is an acute viral illness caused by the measles virus (MeV), a member of the paramyxovirus family. Measles is transmitted via droplets from an infected person's nose, mouth, or throat. Measles occurs worldwide, and it is still a significant cause of childhood disease despite the existence of an effective vaccine. A hospital-based study of children 0-18 months presenting with high fever across selected hospitals within Jos, north-central Nigeria, was conducted between September 2023 and April 2024. Ethical approval and informed consent were obtained before this research study. The seroprevalence of measles virus in children (0-18 months) presenting with high fever in Jos, north-central Nigeria, was determined. A well-structured, standardized questionnaire was used to collect information on biodata, risk factors, and clinical manifestations of measles infection in children. 92 blood samples were collected and analyzed for the measles virus using a commercial ELISA kit. The questionnaire data and laboratory screening results were analyzed using an appropriate statistical tool. A total of 14 samples were positive for measles IgG antibodies, giving a prevalence of 15.2% among children with high fever in Jos. Analysis of risk factors showed statistically significant associations with parents' level of education, occupation, type of family, and nature of residence ($p < 0.05$). This study further established that age, sex, children's nutritional status, vaccination status, vitamin A supplement intake, and parents' occupation, educational status, and family type are important sociodemographic factors that play varying roles in the risk of measles infection in children. On this note, the relationship between measles infection and sociodemographic characteristics showed no statistically significant association ($p > 0.05$) between measles infection and the age and sex of the children. However, children's nutritional and vaccination status, vitamin A supplementation intake, parental occupation, and education were key risk factors for measles infection. Keywords: Measles, Seroprevalence, ELISA, High fever, Risk factors.

INTRODUCTION

Measles is transmitted via droplets from the nose, mouth, or throat of an infected person. It is one of the leading causes of mortality in children younger than five years old. The measles virus, a member of the paramyxovirus family, causes the illness. This virus usually replicates in the cells lining the back of the throat and the lungs. Measles has been reported in at least 33 nations, with over 68,743 cases documented, resulting in infections being introduced into the Americas. In nations where measles has been eradicated, imported cases from other areas continue to present a considerable threat of infection (WHO, 2025). In

sub-Saharan Africa, over 95% of measles-related deaths happen primarily in low-income countries that have fragile healthcare systems. A significant number of these deaths are linked to children who are not vaccinated, as vaccination rates for measles are used as a benchmark for assessing progress (Hayman, 2019).

Approximately 107,500 individuals lost their lives to measles in 2023, predominantly children younger than five years old, even though a safe and affordable vaccine is available. Measles remains prevalent, especially in regions such as Africa, the Middle East, and Asia. A significant number of measles fatalities happen in nations with low-income levels or fragile healthcare

systems that have difficulty immunizing all children (WHO, 2024). Every country faces a risk of measles, and regions with inadequate vaccination rates contribute to the virus's transmission, raising the likelihood of outbreaks and endangering all unvaccinated children. Anyone without immunity, whether vaccinated or unvaccinated, who is not adequately protected can be susceptible to the infection. Pregnant women and young children who have not received the vaccine are at the greatest risk for serious complications from measles (WHO, 2024).

Measles, along with pneumococcal disease and rotavirus diarrhea, remains one of the top preventable causes of child mortality that can be addressed through vaccination. In 2018, even with a reliable and effective immunization program that reached at least 83% of infants under one year old, around 140,000 deaths occurred worldwide (Adekola et al., 2021).

Measles is spread by airborne or droplet transmission. Individuals are infectious from the beginning of the prodromal period, when the first symptoms appear, which are fever, malaise, cough, coryza, and conjunctivitis, to four days after the appearance of the rash. It is one of the most highly communicable infectious diseases. The incubation period is about 10 days (ranging from 7 to 18 days), with a further 2 to 4 days before the rash appears (Chen, 2020).

To infect a host cell, a virus must first attach to a receptor on the cell's exterior and enter the cell. The presence of such a receptor dictates the cell's susceptibility to the virus. Measles is a highly contagious disease characterized by fever, respiratory symptoms, red eyes, and a maculopapular rash. Complications are common and can be quite serious. The rash usually starts on the head before spreading to other areas of the body. The fever can persist and may reach very high temperatures, the rash may last for up to a week, and coughing can continue for around 10 days (Abdulfatai et al., 2017).

Despite the existence of various immunization strategies and an effective vaccine distribution system, measles continues to lead to significant complications. Although a reliable vaccine distribution method has been established, researchers are exploring numerous alternative immunization strategies. One of the primary objectives is to improve the current vaccine administration approach, in part due to concerns regarding injection safety and the disposal of contaminated materials (Hayman, 2019). Additional reasons include the need for vaccine administrators to be medically trained and the goal of minimizing or eliminating the need for cold chain storage. In contrast to other common viral infections, such as varicella-zoster virus,

parvovirus, rubella, and mumps, measles can be fatal. It is estimated that measles-related complications could result in as many as 900,000 deaths worldwide (Hayman, 2019).

In Nigeria, measles is endemic. Despite being a highly contagious disease that may be eradicated, it nevertheless causes a significant rate of child death, especially in developing countries. About 30 million people are infected and killed by the measles virus each year, primarily in developing countries like Nigeria with limited access to healthcare and immunization programs. Before widespread immunization, up to 95% of measles-related deaths happened in developing nations (Hayman, 2010).

The COVID-19 pandemic disrupted both surveillance and vaccination initiatives. The halt of immunization services and a drop in vaccination rates worldwide have left countless children exposed to preventable illnesses such as measles. Measles can affect every nation, and regions with low vaccination rates promote the virus's spread, raising the chances of outbreaks and endangering all unvaccinated children (Cordero, 2024).

MATERIALS AND METHODS

Ethical Approval

Ethical approval for this study was obtained from the Health Research Ethics Committee (HREC) of the Plateau State Specialist Hospital, Jos (NHREC/05/01/2010b). All study procedures were conducted in accordance with institutional guidelines and the National Code for Health Research Ethics. Informed consent was obtained from the parents or guardians of all participants prior to enrolment.

Study design:

This study was conducted in a hospital setting and used a cross-sectional design, focusing on children aged 0 to 18 months with high fever, regardless of socioeconomic background, who visited the chosen hospitals in Jos, North-central Nigeria. A systematic random sampling method was employed to select the participants for the study.

Study Population

The study included children of both genders aged 0 to 18 months who exhibited high fever and other symptoms resembling measles, such as fever, cough, runny nose, conjunctivitis, diarrhoea, vomiting, rash, and Koplik's spots, and who were visiting the hospitals selected for the study.

Data Collection

The research received approval from the ethical committee of Plateau State Specialist Hospital in Jos, Nigeria. Meanwhile, informed consent was secured from the parents, legal guardians, or

caregivers of the children involved in the study. A structured questionnaire comprising both closed- and open-ended questions was used to gather pertinent information on sociodemographic details, risk factors, and clinical presentations of measles infection.

Sample Size Determination and Sampling Method:

The research sample size was determined based on a measles prevalence rate of 8.4% reported by Ibrahim *et al.* (2018). The sample size was calculated using the formula provided by Naing *et al.* (2015):

$$n = Z^2 P (1-P) / d^2$$

Where n represents the sample size;

P is the prevalence derived from prior research = 6.4% = 0.064, as cited by Ibrahim *et al.* (2018); Z is the standard normal distribution value for a 95% confidence level = 1.96;

d is the absolute desired precision of 5%, given as 0.05.

Thus, the computed sample size was 92.08; however, a total of 94 samples were collected.

Sample Collection, Preparation, and Processing

All necessary materials (sterile containers, syringes, needles, tourniquets, and cotton swabs) for venous blood collection were gathered, and the sterile anticoagulant containers were labelled with the participants' identification numbers. Aseptic venipuncture was performed to collect two milliliters (2ml) of blood from each child and was deposited into the sterile labeled anticoagulant containers containing EDTA. The blood samples were centrifuged, and the plasma obtained was used for analysis.

Screening for Measles IgG using ELISA

Plasma samples were examined for the presence of measles virus using the Enzyme-Linked Immunosorbent Assay (ELISA) method with the Measles IgG Assay kit (Diagnostic Automation, U.S.A.).

Procedure for the ELISA test:

All reagents and the microtiter ELISA plate were allowed to reach room temperature for 30 minutes before usage. A control blank was prepared without any solution. Using a micropipette, 100 μ L of negative control and 100 μ L of positive control were added to wells 1 and 2, respectively. The appropriate wells were then filled with 100 μ L of the sample, which was covered with an adhesive strip and incubated for 30 minutes at 37°C. The wells were subsequently washed thoroughly with distilled water, and any excess wash buffer was discarded by tapping the plate on a clean absorbent tissue after the final wash. Two drops of reagent 1 (blue solution) were applied to each well (excluding the blank), and the wells were

incubated at room temperature for 5 minutes. The wells were washed again, and then two drops of reagent 2 (red solution) were added to each well (except for the blank), followed by another 5-minute incubation and subsequent washing. Two drops of stop solution were added to each well, and the plate was gently tapped on the side to mix. Taking the blank as a baseline, the optical density for each well was measured within 10 minutes using a microplate reader set to 450nm. In addition, results were visually evaluated, so any sample well that appeared more yellow than the positive control was classified as positive, while any sample well that did not appear more yellow than the negative control or was colourless was classified as negative. Furthermore, any sample well with an absorbance reading of 0.15 or higher was deemed positive, while those with readings below 0.15 were considered negative.

Data analysis and result presentation

Data collected from the questionnaire, along with the outcomes of the laboratory analyses, were statistically evaluated using the Statistical Package for the Social Sciences (SPSS) version 26 to examine significant differences among variables using the chi-square test. A statistical significance level was established at (P<0.05) with a 95% confidence interval, and the findings were summarized in frequency tables, ratios, and percentages.

RESULTS

The prevalence of Measles Virus Immunoglobulin G antibodies in this study is 15.2%, as shown in Table 1. The analysis of infection rates by age showed the highest prevalence (66.7%) in children aged 10-12 months, while the lowest prevalence (0.0%) occurred in those aged 16-18 months. Nevertheless, there was no statistically significant correlation between the occurrence of measles infection and the age of children experiencing high fever in this group (P=0.13%). Regarding sex, the occurrence rate was comparable in females (15.4%) and males (15.1%), indicating no significant association between measles virus infection and gender among children with high fever in Jos, north-central Nigeria (p=0.51), as illustrated in Table 1.

The relationship between parental socio-economic status and measles incidence in children was examined, focusing on the mother's educational level. The analysis revealed no significant association between parents' educational attainment and measles virus infection (p=0.76). In this context, children of mothers with only primary education had the highest prevalence rate at 16.7%, whereas the lowest prevalence was observed in children

whose mothers had completed tertiary education, at 14.3%, as illustrated in Table 2. Regarding mothers' occupation, there was a statistically significant association (P=0.04) between measles infection and parents' occupation. In this regard, children whose parents were full-time housewives had the highest prevalence of measles infection (19.1%), and the lowest prevalence was observed in children whose parents were civil servants (0.1%) as presented in Table 2 below. Similarly, there was a statistically significant association between family type and measles infection in children (P=0.03). Kids from polygamous families showed the lowest prevalence of measles infection at 10.0%, whereas those from monogamous families exhibited the highest prevalence at 15.9%, as indicated in Table 2. The examination of outcomes regarding the living situation of parents and measles infection in their offspring reveals minimal variation in measles infection rates among children with parents in self-contained apartments (14.6%) compared to those with parents in shared apartments (15.7%). Therefore, no statistically significant association was found between measles virus infection and parents' residential status (P=0.95), as shown in Table 2. The analysis of measles infection in children presenting with high fever in relation to some major risk factors revealed that only breast-feeding status was statistically significantly associated (p=0.01) with measles infection in

children, where higher measles infection occurred in children who were not breastfed (20.0) as against 14.9 prevalence in children who were breastfed, as shown in Table 3 below. However, analysis for immunization status, the number of children in the house, and the overall number of people in the household with measles infection revealed no statistically significant association (P>0.05), even though higher measles infection (23.8%) occurred in children who were immunized, as against 12.7% prevalence in children who were not immunized. Additionally, a greater incidence of measles (15.4%) was noted in children whose mothers had between 6 to 10 children, compared to a 14.3% prevalence seen in children of mothers with a smaller number of children (5 or fewer). In terms of household size, a higher rate of measles infection (26.7%) was recorded in children from households with fewer members (0-5) than the 13.0% prevalence found in children from larger households (more than 5), as illustrated in Table 3. An examination of the primary clinical symptoms indicated that fever, cough, runny nose, and conjunctivitis (eye inflammation) were the predominant signs in children with high fever in this study. Among the children with inflamed eyes, the measles infection rate was the highest at 50.0%, while it was lowest at 13.0% among those presenting with cough, with no significant association between measles infection and the clinical symptoms, as illustrated in Table 4.

Table 1: Distribution of Measles Infection in Children Presenting with High Fever by Age and Sex of Children

Age (month)	Number tested	No. Positive (%)	P-value
1-3	43	4(9.1)	0.13
4-6	24	4(16.7)	
7-9	9	1(11.1)	
10-12	3	2(66.7)	
13-15	6	3(50.0)	
16-18	7	0(0.0)	
Total	92	14(15.2)	
Sex			
Females	39	6(15.4)	0.51
Males	53	8(15.1)	
Total	92	14(15.2)	

Key: P= level of significance at 0.05, % = percentage, No. =number

Table 2: Distribution of Measles Infection in Children Presenting with High-fever with Mothers' Socio-economic Status

Socio-economic Factors	No. tested	No. Positive (%)	P-value
Mothers' Educational Level			
Primary	13	2(16.7)	0.76
Secondary	72	11(15.3)	
Tertiary	7	1(14.3)	
Total	92	14(15.2)	
Mothers' Occupation			
Full Housewife	42	8(19.1)	0.04*
Self-employed	43	6(13.9)	
Civil servant	6	0(0.0)	
Total	92	14(15.2)	
Type of Family			
Monogamous	82	13(15.6)	0.03*
Polygamous	10	1(10.0)	
Total	92	14(15.2)	
Type of Residence			
Self-contained	41	6(14.6)	0.95
Shared apartment	51	8(15.2)	
Total	92	14(15.2)	

Key: P= level of significance at 0.05, * = significance at $P \leq 0.05$, % = percentage, No. = number

Table 3: Distribution of Measles Infection in Children with High-fever with Major Risk Factors

Risk Factors	No. tested	No. Positive (%)	P-value
Immunization status			
Yes	21	5(23.8)	0.81
No	71	9(12.7)	
Total	92	14(15.2)	
Breastfeeding Status			
Yes	87	13(14.9)	0.01**
No	5	1(20.0)	
Total	92	14(15.2)	
No. of Children			
1-5	14	2(14.3)	0.91
6-10	78	12(15.4)	
Total	92	14(15.2)	
No. in Household			
≤ 5	15	4(26.7)	0.17
> 5	77	10(13.0)	
Total	92	14(15.2)	

Key: P= level of significance at 0.05, * = significance at $P \leq 0.05$, % = percentage, No. = number

Table 4: Distribution of Measles Infection in Children with High-fever with Major Risk Factors

Clinical Presentations	Number Tested	Positive (%)	P-value
Fever	40	6(15.0)	0.06
Cough	23	3(13.0)	
Runny nose	27	4(14.8)	
Conjunctivitis/inflamed eyes	2	1(50.0)	
Total	92	14(15.2)	

Key: P= level of significance at 0.05, % = Percentage

DISCUSSION

In this study, the prevalence of measles IgG antibodies in children with high fever was 15.2%. Given the study population's vulnerability, this prevalence is considered high, as measles infection is highly preventable with available vaccines. This prevalence corresponds to 15.6%

reported by Omilabu et al. (2019) in a similar study in Lagos and to 14.6% reported by Adekola et al. (2021) in Abuja, Nigeria, for children. This is likely due to similarities in population characteristics and risk factors observed in the two populations. However, the current prevalence is higher than the 10.7% prevalence

reported in a similar study in Maiduguri, Borno state (Olasaju *et al.*, 2024). However, the current prevalence is lower than the 45.2% reported in an earlier study in Jos by Junaid *et al.* (2011) and the 43.3% reported in another study in 2018 in Zamfara by Aliyu *et al.* (2018). The observed differences may be attributed to the varying levels of commitment and dedication of relevant authorities in ensuring better measles vaccine coverage and promoting adequate campaigns to enlighten communities in that region, as compared to what is obtainable in this part of the country. This is because accelerated measles control activities, including improved routine immunization coverage and timely services, have been documented to reduce measles-associated morbidity and mortality (Manirakiza *et al.*, 2011).

Furthermore, the measles prevalence by age indicated that children aged 10-12 months in Plateau state were most susceptible to measles virus infection, and the elderly were least susceptible. This observation is similar to previous findings showing that 58% of infants lose their protective antibodies by 4 months and 97% by 7-9 months, respectively (Abdulfatai *et al.*, 2017). However, the observation of decreased susceptibility with increasing age may not be unrelated to improvements in the immune system as children grow and become more active in association with the elderly and caregivers, affording them a better opportunity to monitor than the more gullible younger children.

Regarding mothers' educational level, the majority of children screened were from mothers with secondary education, and least among mothers with tertiary education, where a progressive decline in the prevalence of measles infection was observed as the mother's education level increased, thus the lowest prevalence occurred in children from mothers with tertiary education, although there was no statistically significant association ($P > 0.05$) between mothers educational status and measles infection in their children. This observation may partly be because studies have shown that educated mothers tend to be more concerned with their children's immunization schedules than less educated women (Muhammed and Danish, 2014). The reason may also partly be due to greater awareness of better ways to prevent and manage childhood infections. This finding is consistent with the reports by Endalamau *et al.* (2024) in Africa and by Lee *et al.* (2020) in Asia.

There was, however, a statistically significant association ($P = 0.04^*$) between parental occupation and measles virus infection in febrile children in this study, in which children of non-

working parents (full-time Housewives) were more susceptible to measles infection, a finding contrary to the report of Olaitan *et al.*, 2015, as shown in Table 2.

There was no significant association statistically between the number of children in the family and the seroprevalence of measles infection. Children of parents with more than 5 children had the highest prevalence, while those of parents with fewer than 5 children had the lowest, as shown in Table 3. This is consistent with the previous study by Junaid *et al.* (2011) in Jos, Nigeria. This may not be unconnected with the burden of catering for more children, which requires more of everything, thus straining caregivers and likely leading to a compromise in the standard of care offered to all the children.

The measles immunization status of children was not statistically significantly associated with the prevalence of measles infection among febrile children in Jos, Nigeria. Thus, measles prevalence was higher in vaccinated children than in unvaccinated children, as shown in Table 3. This observation, although not in line with the expected outcome of vaccination, may not be unconnected with incomplete or inappropriate vaccine practice, which is common among children of uneducated/unenlightened mothers. Furthermore, a sense of invincibility can persist even when vaccination is not administered properly or incompletely. Where this notion exists, some caregivers neglect even the most basic care owing to a mindset of protection against vaccination. A similar finding was reported in Olufadewa's 2024 study on measles vaccine effectiveness in Nigeria.

A statistically significant relationship ($P = 0.01^{**}$) was also observed between breastfeeding status and measles prevalence. Children who were not breastfed had a higher incidence of measles than those who were. This indicates that non-breastfed children had a 20.0% increased risk of contracting measles compared to breastfed children (14.9%). This aligns with the findings of Muthiah *et al.* (2021), which demonstrated that antibody transfer from mothers to newborns is effective, providing protection until infants reach 6-7 months of age.

This research investigated the association between measles virus infection and children's symptoms. The findings indicated that none of the symptoms (fever, cough, coryza, diarrhea, and vomiting) were significantly associated with the measles virus. Therefore, a child infected with the measles virus may typically show some or all of these symptoms. This is consistent with the WHO's clinical case definition, which states that any individual who has a history of fever (39

to 41°C) lasting three days or more and a generalized maculopapular rash, along with one of the following symptoms: coryza, cough, or conjunctivitis (Abdulfatai *et al.*, 2017).

In this study, among children presenting with high fever and other related symptoms, only 14 (15.2%) tested positive for measles IgG. This research supports the notion that measles remains endemic in Nigeria (Adekola *et al.*, 2021). This situation has been linked to the early depletion of passively acquired maternal antibodies in these children, which differs among individuals. Therefore, it is essential to reconsider the vaccination age in Nigeria and adjust it back to six (6) months, as advised by WHO (Muthiah *et al.*, 2021). This viewpoint aligns with earlier studies conducted by Adeboye *et al.* (2011), Nujum *et al.* (2015), and Oduoye *et al.* (2023).

CONCLUSION AND RECOMMENDATIONS

The burden of measles in northern Nigeria remains concerning despite various efforts to eliminate it. The results of this research confirm the presence of the measles virus among children aged 0-18 months in Plateau State, with a seroprevalence similar to that observed in various regions of the country. The prevalence identified in this research suggests that measles

continues to be a concern in Plateau State, with non-breastfed infants being the most vulnerable. This situation remains a public health challenge, even with the availability of a safe and effective vaccine.

In light of the research findings and the conclusions drawn, we propose re-evaluating the vaccination age for infants and intensifying the immunization campaign to strengthen the fight against measles virus infection. Ensuring that effective and potent vaccines are available to all children is crucial. Awareness and education initiatives for parents highlighting the importance of vaccination should be developed. Parents should be encouraged to consistently take their children for routine immunizations. A reassessment of the vaccination age in Nigeria is warranted, suggesting a return to six (6) months. Additionally, further research on measles IgG levels in infants is needed to determine maternal antibody levels and the precise age at which these antibodies diminish. More importantly, we recommend that further research be strengthened by incorporating molecular detection techniques, such as the polymerase chain reaction or immunofluorescence, to enhance immunodiagnostic value and provide direct confirmation of active measles viral infection.

REFERENCES

- Abdulfatai, K., Olonitola, O. S., Aminu, M., & Jatau, E. D. (2017). Seroprevalence of measles virus among children 0-12 years of age in some states in north western Nigeria. *International Journal of Current Microbiology and Applied Sciences*, 6(7), 2584-2594. [Crossref]
- Adeboye, M., Adesiyun, O., Adegboye, A., Eze, E., Abubakar, U., Ahmed, G., Usman, A., Amos, S., & Rotimi, B. (2011). Measles in a tertiary institution in Bida, Niger state, Nigeria: Prevalence, immunization status and mortality pattern. *Oman Medical Journal*, 26(2), 114-117. [Crossref]
- Adekola, H. A., Abdullahi, I. N., Emeribe, A. U., Faruku, N., Uzairue, L., Adeyemi, B., Billyrose, O. M., & Shuwa, H. A. (2021). Sero-survey of measles virus antibodies among symptomatic children attending Abuja teaching hospital, Nigeria. *GMS Hygiene and Infection Control*, 16(4), 10-32. PMID: 33643771
- Aliyu, M. Y., Olonitola, O. S., & Ella, E. E. (2018). Seroprevalence of measles infection among children in Zamfara state. *Bayero Journal of Pure and Applied Sciences*, 11(1), 343-348. [Crossref]
- Aworabhi-Oki, N., Numbere, T., Balogun, M. S., Usman, A., Utulu, R., Ebere, N., Omubo, W., Stow, J., Abba, S., & Olorukoobi, A. (2020). Trends in measles cases in Bayelsa State, Nigeria: A five-year review of case-based surveillance data (2014-2018). *BMC Public Health*, 20, 938-941. [Crossref]
- Baba, U. A., Rabasa, A. I., Bukbuk, D., Musa, A. B., Bashir, F., Chama, R., Abdulrahim, H., & Fate, B. Z. (2013). Does placental malaria infection impair the passage of measles antibodies from mothers to their newborn infants? *Global Advanced Research Journal of Medicine and Medical Sciences*, 2(1), 001-005.
- Chen, H. L., & Tang, R. B. (2020). Measles re-emerges and recommendation of vaccination. *Journal of the Chinese Medical Association*, 83(1), 5-7. [Crossref]
- Cordero, D. A., Jr. (2024). Another measles outbreak in the Philippines? The essentiality of a successful vaccination program and public cooperation. *Human Vaccines & Immunotherapeutics*, 20(1), 2312605. [Crossref]
- Endalamaw, D., Nibret, E., Munshea, A., Mekonnen, F., Tadesse, S., Zeru, T., Tefera, M., & Yismaw, G. (2024).

- Measles vaccine effectiveness in African children: A systematic review and meta-analysis. *BMC Infectious Diseases*, 24(1330), 10224-10239. [\[Crossref\]](#)
- Gastañaduy, P. A., Goodson, J. L., Panagiotakopoulos, L., Rota, P. A., Orenstein, W. A., & Pate, M. (2021). Measles in the 21st century: Progress toward achieving and sustaining elimination. *The Journal of Infectious Diseases*, 224(4), 42-427. [\[Crossref\]](#)
- Hayman, D. T. S. (2010). Measles vaccination in an increasingly immunized and developed world. *Human Vaccines & Immunotherapeutics*, 15(1), 28-33. [\[Crossref\]](#)
- Hayman, D. T. S. (2010). Measles vaccination in an increasingly immunized and developed world. *Human Vaccine and Immunotherapeutics*, 15(1), 28-33. [\[Crossref\]](#)
- Ibrahim, B. S., Usman, R., Mohammed, Y., Datti, Z., Okunromade, O., Abubakar, A. A., & Nguku, P. M. (2019). Burden of measles in Nigeria: A five-year review of case-based surveillance data, 2012-2016. *Pan African Medical Journal*, 22(1), 5-23. [\[Crossref\]](#)
- Junaid, S. A., Akpan, K. J., & Olabode, A. O. (2011). Sero-survey of rubella IgM antibodies among children in Jos, Nigeria. *Virology Journal*, 8(244), 2-5. [\[Crossref\]](#)
- Lee, Y., Lee, Y. H., Lu, C. W., Cheng, S. Y., Yang, K. C., & Huang, K. C. (2020). Measles immunity gaps in an era of high vaccination coverage: A serology study from Taiwan. *Travel Medicine and Infectious Disease*, 36, 101-108. [\[Crossref\]](#)
- Manirakiza, A., Kipela, J. M., & Sosler, S. (2011). Seroprevalence of measles and natural rubella antibodies among children in Bangui, Central African Republic. *BMC Public Health*, 11(327), 172-186. [\[Crossref\]](#)
- Muhammed, A., & Danish. (2014). Relationship between child immunization and household socio-demographic characteristics in Pakistan. *Journal of Humanities and Social Sciences*, 6(7), 90-102.
- Muthiah, N., Galagoda, G., Handunnetti, S., Peiris, S., & Pathirana, S. (2021). Dynamics of maternally transferred antibodies against measles, mumps, and rubella in infants in Sri Lanka. *International Journal of Infectious Diseases*, 107, 129-134. [\[Crossref\]](#)
- Nujum, Z. T., & Varghese, S. (2015). Investigation of an outbreak of measles: Failure to vaccinate or vaccine failure in a community of predominantly fishermen in Kerala. *Journal of Infection and Public Health*, 8(1), 11-19. [\[Crossref\]](#)
- Oduoye, M. O., Zuhair, V., Marbell, A., Olatunji, G. D., Khan, A. A., Farooq, A., Jamiu, A. T., & Karim, K. A. (2023). The recent measles outbreak in the South African region is due to low vaccination coverage. What should we do to mitigate it? *New Microbes and New Infections*, 29(54), 101-104. [\[Crossref\]](#)
- Olaitan, A. E., Ella, E. E., & Ameh, J. B. (2015). Comparative seroprevalence of measles virus immunoglobulin M antibodies in children aged 0-8 months and a control population aged 9-23 months presenting with measles-like symptoms in selected hospitals in Kaduna state. *International Journal of General Medicine*, 10(8), 101-108. [\[Crossref\]](#)
- Olasoju, T. O., Olasoju, M. I., Daggash, B. B., Abaye, B. B., Enumah, C., Isah, S., Bolori, M. T., & Adebowale, O. O. (2024). Measles outbreak in Lambu internally displaced persons' camp, Maiduguri, Borno State, Nigeria, 2017. *Journal of Interventional Epidemiology and Public Health*, 7(2), 9-25. [\[Crossref\]](#)
- Olufadewa, I., Bamidele, D., Olufadewa, T., Adesina, M., & Oladele, R. (2024). Combating recurrent measles outbreaks in Nigeria: Short-term and long-term strategies. *Journal of Medicine, Surgery, and Public Health*, 3, 1001-1023. [\[Crossref\]](#)
- Omilabu, S. A., Oyefolu, A. O., Ojo, O. O., & Audu, R. A. (2019). Potency status and efficacy of measles vaccine administered in Nigeria: A case study of three EPI centers in Lagos, Nigeria. *African Journal of Medical Sciences*, 28(3-4), 209-212. PMID: 11205835
- World Health Organization / Pan American Health Organization. (2025). *Epidemiology alert. Measles in the Americas region*. www.paho.org.
- World Health Organization. (2024). *Immunization data- Provisional measles and rubella data*. [\[Link\]](#)