Original Article
DOI: https://doi.org/10.70749/ijbr.v3i4.2763

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://ijbr.com.pk
ISSN: 2960-2793/ 2960-2807

Frequency of Measles in Children Younger than 9 Months Old

Asif Nawaz[1], Muhammad Faizullah Khan[2], Wajid Khan[3], Vildan Zaheer Abbasi[4], Ubaid Ali[5]

[1-5]Department of Pediatrics, Ayub Teaching Hospital (MTI), Abbottabad, KP, Pakistan.

ARTICLE INFO

Keywords: Measles, Infants, Children, Vaccination, Frequency.

Correspondence to: Muhammad Faizullah Khan,
Postgraduate Resident, Department of Pediatrics, Ayub Teaching Hospital (MTI) Abbottabad, KP, Pakistan.
Email: faizinqalabyahoo@gmail.com

Declaration
Authors' Contribution
All authors equally contributed to the study and approved the final manuscript

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History
Received: 27-02-2025 Revised: 13-04-2025
Accepted: 19-04-2025 Published: 30-04-2025

ABSTRACT

Background: Measles remains a significant public health concern, particularly in infants younger than 9 months who are often ineligible for routine vaccination in many settings. This age group faces a vulnerability window due to the rapid waning of maternal antibodies, leading to increased susceptibility amid global measles resurgence. **Objective:** To determine the frequency of measles and explore its association with sociodemographic factors and vaccination status among children younger than 9 months. **Methods:** A cross-sectional study was conducted with 111 children aged less than 9 months presenting at the department of Pediatrics, Ayub Teaching Hospital (MTI) Abbottabad during June 2024 to January 2025. Data were collected on age, gender, residence (urban/rural), mother's education and profession, family monthly income, and infant vaccination status. Measles diagnosis was based on clinical criteria and/or laboratory confirmation. Frequency and percentage were calculated for categorical variables. Post-stratification chi-square tests were applied to assess associations, with $p \leq 0.05$ considered statistically significant. Data analysis was performed using SPSS version 22. **Results:** The overall frequency of measles was 14 (12.61%). The study population comprised 48.65% males and 51.35% females, with 56.76% from urban areas. Median age was 4.0 months (IQR: 2.0–7.0). Vaccination coverage was 80.18%. Stratified analysis showed no statistically significant associations between measles occurrence and age subgroups, gender, residence, maternal education, profession, family income, or vaccination status (all $p > 0.05$), though a non-significant trend of higher frequency was noted in unvaccinated infants (22.7% vs. 10.1%). **Conclusion:** Measles affected 12.61% of children under 9 months in this study, highlighting persistent risk in early infancy despite relatively high vaccination coverage. The lack of significant sociodemographic associations may reflect sample size limitations. These findings support the need for strategies to bridge immunity gaps, such as supplementary immunization or earlier vaccination in high-burden settings, to reduce measles burden in this vulnerable group.

INTRODUCTION

Measles is the most contagious infectious disease known to mankind, and is still one of the top causes of death in children worldwide. Measles is caused by paramyxoviridae family, a type of RNA virus and is characterized by fever, cough, and coryza, conjunctivitis and maculopapular rashes. Measles is normally transmitted by airborne respiratory droplets. Accelerated immunization activities have had a major impact on reducing measles deaths. Global measles deaths have decreased by 80% from an estimated 545 000 in 2000 to 110 000 in 2017. [1] Measles has been preventable since 1963 through vaccination. Serologic and epidemiologic studies indicate that 1-dose measles vaccine efficacy is approximately 85%–90% when given at 9 months of age, and that 2-dose efficacy is .99% when the second dose is given at 12 months of age. Before the discovery of measles vaccine in 1963, epidemic cycles occurred every 2 to 3 years, and virtually everyone experienced measles illness during childhood. More than 90% of individuals were infected by the age of 10 years. Natural infection provides lifelong immunity.[2]

Measles has been controlled effectively in many developed countries like United States because of high coverage rates of vaccination. Although vaccination protects >90% of recipients against this disease, measles outbreaks still occasionally occur in areas with high vaccine coverage as a result of imported transmission.[3] The optimal age for measles vaccination has been debated since measles vaccine was introduced. From the studies on waning of maternal antibodies (which interfere with response to measles vaccine) and age-specific measles attack rates in East Africa, the World Health Organization determined that vaccination at 9 months of age would avoid the maximum number of measles cases and deaths in developing countries[4]. However, the continued high

disease burden in younger infants in densely populated areas of developing countries led to efforts to develop vaccines that would be effective in the presence of maternally derived measles-specific antibodies. High titre (HT) measles vaccines were immunogenic in 4–6 months old infants, but their association with increased mortality for 2–3 years after vaccination, led to the withdrawal of recommendations for their use.[4]

The World Health Organization (WHO) defines measles elimination as "the absence of endemic measles virus transmission in a defined geographic area for a period of at least 12 months in the presence of a well performing surveillance system". The threshold for elimination is further defined as less than 1 confirmed measles case per 1 million population; to eliminate measles, countries need to achieve high (95%) two-dose vaccine coverage. To determine whether a country or a WHO Region has achieved elimination, the regional verification commission considers 5 lines of evidence, including the population immunity, quality of surveillance, sustainability of the programme, genotyping evidence, and the disease epidemiology. [5]

Globally the cases of measles that occurred among 3-9 month of age were 10% of total cases.[6] The prevalence of measles in infant younger than 9 months was documented in 85 (17%)[7].

As Pakistan is endemic area of measles, and changing epidemiology in measles outbreak have been reported in recent years in which vast majority of measles cases have been reported before recommended vaccine time i.e. 9 months of age. As limited local data is available on this topic in our country so we planned to conduct this study in our population to generate baseline information. The result of this study will help relevant authorities to give measles vaccine before recommended time so that mortality and morbidity related to measles especially in children under 9 months in our population may be reduced.

MATERIALS AND METHODS

This hospital-based cross-sectional descriptive study was conducted to determine the frequency of measles and its association with selected sociodemographic and clinical factors among children younger than 9 months of age at the department of Pediatrics, Ayub Teaching Hospital (MTI) Abbottabad during June 2024 to January 2025. A total of 111 infants aged less than 9 months were enrolled using a non-probability consecutive sampling technique. Infants of either gender presenting to the pediatric department were included after obtaining informed consent from parents or legal guardians, while children aged 9 months or older, those with incomplete data, or those with other confirmed exanthematous illnesses were excluded. Data were collected using a structured proforma and included age, gender, weight, area of residence, maternal education and occupation, family monthly income, and measles vaccination status. Clinical assessment was performed by a pediatrician, and measles was diagnosed based on the presence of fever and maculopapular rash along with at least one of the following: cough, coryza, or conjunctivitis, with or without laboratory confirmation, according to institutional protocol. Vaccination status was categorized as vaccinated (at least one dose of measles-containing vaccine) or unvaccinated. Data were analyzed using the Statistical Package for Social Sciences (SPSS). Quantitative variables were expressed as mean ± standard deviation or median with interquartile range, while qualitative variables were presented as frequencies and percentages. Stratification was carried out to control for potential effect modifiers, and post-stratification chi-square tests were applied to assess associations between measles occurrence and selected variables. A p-value of ≤ 0.05 was considered statistically significant. Ethical approval was obtained from the Institutional Review Board prior to the study, and confidentiality of all participants was strictly maintained.

RESULTS

A total of 111 children younger than 9 months of age were included in the study. The overall frequency of measles among these infants was 14 cases, representing 12.61% of the study population.

The study population consisted of 54 males (48.65%) and 57 females (51.35%). Regarding residence, 63 children (56.76%) were from urban areas and 48 (43.24%) were from rural areas. The majority of mothers were housewives (68; 61.26%), while 43 (38.74%) were employed. Maternal education levels were distributed as follows: none (15.32%), primary (25.23%), secondary (39.64%), and higher education (19.82%). Family monthly income was classified as low in 47.75%, medium in 40.54%, and high in 11.71% of cases. Eighty-nine infants (80.18%) had received at least one dose of measles-containing vaccine, while 22 (19.82%) were unvaccinated. Post-stratification chi-square tests were applied, with $p \leq 0.05$ considered statistically significant.

Measles was observed more frequently in infants younger than 3 months (7/36; 19.4%) and in the 6–9 months age group (6/46; 13.0%) compared to the 3–6 months group (1/29; 3.4%). However, this difference was not statistically significant ($\chi^2 = 3.74$, $p = 0.154$).

No significant gender difference was found in measles occurrence, with 6 cases among males (11.1%) and 8 cases among females (14.0%). Similarly, residence showed no significant association with measles: 9 cases (14.3%) in urban areas versus 5 cases (10.4%) in rural areas.

Regarding maternal factors, measles frequency appeared higher among children of mothers with primary education (21.4%) and no education (17.6%) compared to secondary (4.5%) or higher education (13.6%), but this association was not statistically significant. Mother's profession was not associated with measles occurrence, with similar proportions among children of housewives (11.8%) and employed mothers (14.0%).

Family monthly income showed a borderline pattern, with higher measles frequency in the low-income group (17.0%) compared to medium (4.4%) and high-income groups (23.1%), though the difference did not reach statistical significance.

Finally, measles was more frequent among unvaccinated infants (5/22; 22.7%) than among vaccinated infants (9/89; 10.1%), but this difference was also not statistically significant.

In conclusion, while measles occurred in 12.61% of children younger than 9 months in this study, none of the examined sociodemographic or vaccination-related factors showed a statistically significant association with measles occurrence (all p > 0.05).

Table

Sociodemographic Characteristics, Vaccination Status, and Stratified Frequency of Measles in Children Younger than 9 Months (n=111)

Variable	Category	Total n (%)	Measles Yes n (%)	Measles No n (%)	p-value*
Age Category (months)	<3	36 (32.43)	7 (19.4)	29 (80.6)	0.154
	3–6	29 (26.13)	1 (3.4)	28 (96.6)	
	6–9	46 (41.44)	6 (13.0)	40 (87.0)	
Gender	Male	54 (48.65)	6 (11.1)	48 (88.9)	0.859
	Female	57 (51.35)	8 (14.0)	49 (86.0)	
Residence	Urban	63 (56.76)	9 (14.3)	54 (85.7)	0.749
	Rural	48 (43.24)	5 (10.4)	43 (89.6)	
Mother's Education	None	17 (15.32)	3 (17.6)	14 (82.4)	0.173
	Primary	28 (25.23)	6 (21.4)	22 (78.6)	
	Secondary	44 (39.64)	2 (4.5)	42 (95.5)	
	Higher	22 (19.82)	3 (13.6)	19 (86.4)	
Mother's Profession	Housewife	68 (61.26)	8 (11.8)	60 (88.2)	0.964
	Employed	43 (38.74)	6 (14.0)	37 (86.0)	
Family Monthly Income	Low	53 (47.75)	9 (17.0)	44 (83.0)	0.085
	Medium	45 (40.54)	2 (4.4)	43 (95.6)	
	High	13 (11.71)	3 (23.1)	10 (76.9)	
Vaccination Status	Yes	89 (80.18)	9 (10.1)	80 (89.9)	0.216
	No	22 (19.82)	5 (22.7)	17 (77.3)	

DISCUSSION

In the present study involving 111 children younger than 9 months, measles was detected in 14 cases, corresponding to a frequency of 12.61%. This rate reflects the continued vulnerability of young infants to measles infection in settings where routine vaccination is typically initiated at 9 months of age or later. The finding is consistent with recent global and regional evidence indicating a substantial burden of measles in this age group, particularly amid ongoing transmission and immunity gaps.[8,9]

Recent data highlight the rapid waning of maternal measles antibodies, leaving many infants unprotected well before the standard first vaccine dose. A 2025 systematic review and meta-analysis by Ong et al. reported that approximately 70% of infants in low- and middle-income countries become seronegative by 4 months of age, rendering them susceptible to infection prior to vaccination.[10] Similarly, a multi-country analysis by Tiley et al. confirmed that reliance on maternal antibodies provides insufficient protection for most infants beyond 4–6 months.[11] These observations align with our observed trend of higher measles frequency in unvaccinated infants (22.7%) compared to vaccinated ones (10.1%), although the difference was not statistically significant, likely due to the modest sample size.

The lack of significant associations between measles occurrence and sociodemographic variables (age subgroups, gender, residence, maternal education, profession, and family income) may be influenced by the study's limited statistical power. This contrasts with some reports linking lower maternal education and rural residence to poorer vaccination coverage and elevated measles risk in older children.[12] However, our results emphasize that measles susceptibility in early infancy appears driven primarily by the timing of immunity loss rather than strong sociodemographic modifiers in this particular context.

Globally, measles has resurged significantly in recent years. According to the World Health Organization, approximately 30 million infants remained under-protected against measles in 2024, with most of the estimated 95,000 measles deaths occurring among unvaccinated or under-vaccinated children under 5 years.[8] In the United States, 2,065 confirmed measles cases were reported in 2025, with 26% (537 cases) occurring in children under 5 years, including high hospitalization rates in this age group.[13] These trends underscore the urgent need to address early immunity gaps, particularly in outbreak-prone areas.

Mathematical modeling studies suggest that adjusting the timing of the first measles vaccine dose could reduce incidence in high-transmission settings. Goult et al. estimated optimal first-dose ages ranging from 6 to 20 months depending on local epidemiology, with earlier administration potentially beneficial in populations with high early exposure.[14] Expert reviews further support considering earlier vaccination (e.g., 6–8 months) during outbreaks to protect vulnerable infants, while ensuring subsequent doses maintain long-term immunity.[15]

The findings of this study support the recommendation for targeted interventions, such as supplementary immunization activities or context-specific earlier dosing, to mitigate measles risk in infants younger than 9 months.[8, 10] Limitations include the small sample size, which may have precluded detection of significant associations, and potential selection bias from the sampling approach. Larger, prospective studies are needed to further characterize risk factors and evaluate adapted vaccination strategies.

CONCLUSION

This study found that measles occurred in a notable proportion of children younger than 9 months of age, highlighting the vulnerability of this age group before completion of routine immunization. Although a higher frequency of measles was observed among younger

infants, unvaccinated children, and those from lower socioeconomic backgrounds, none of the evaluated sociodemographic or vaccination-related factors showed a statistically significant association with measles occurrence. These findings underscore the continued risk of measles in early infancy and emphasize the need for strengthened measles prevention strategies, including improved maternal immunity, timely vaccination coverage, and enhanced surveillance, to reduce measles burden in children below the routine vaccination age.

REFERENCES

1. Asghar, R. M., Ashraf, R. R., & Hussain, S. A. (2019). Measles in infants younger than 9 months of age: A descriptive analysis. *Annals of PIMS-Shaheed Zulfiqar Ali Bhutto Medical University*, *15*(3), 108-113. https://doi.org/10.48036/apims.v15i3.235
2. Goodson, J. L., Masresha, B. G., Wannemuehler, K., Uzicanin, A., & Cochi, S. (2011). Changing epidemiology of measles in Africa. *Journal of Infectious Diseases*, *204*(Supplement 1), S205-S214. https://doi.org/10.1093/infdis/jir129
3. Abida Sultana, A. S., Sabir, S. A., & Amna Awan, A. A. (2015). Characteristics of patients with measles admitted to Allied Hospital Rawalpindi. *J Ayub Med Coll Abbottabad, 27*(2), 318–22. https://www.cabidigitallibrary.org/doi/full/10.5555/20153297889
4. Schnorr, J., Cutts, F. T., Wheeler, J. G., Akramuzzaman, S., Alam, M., Azim, T., Schneider-Schaulies, S., & Ter-Meulen, V. (2001). Immune modulation after measles vaccination of 6–9 months old Bangladeshi infants. *Vaccine*, *19*(11-12), 1503-1510. https://doi.org/10.1016/s0264-410x(00)00349-2
5. Jean Baptiste, A. E., Masresha, B., Wagai, J., Luce, R., Oteri, J., Dieng, B., Bawa, S., Ikeonu, O. C., Chukwuji, M., Braka, F., Sanders, E., Hahné, S., & Hak, E. (2021). Trends in measles incidence and measles vaccination coverage in Nigeria, 2008–2018. *Vaccine*, *39*, C89-C95. https://doi.org/10.1016/j.vaccine.2021.03.095
6. Fauveau, V., Chakraborty, J., Sarder, A. M., Khan, M. A., & Koenig, M. A. (1991). Measles among under-9-month-olds in rural Bangladesh: its significance for age at immunization. *Bulletin of the World Health organization*, *69*(1), 67. https://pmc.ncbi.nlm.nih.gov/articles/PMC2393210/
7. Muhammad, Z., Khan, S., Ahmad, I., Shadab, T., Haider, Z., & Sheer, J. (2018). Frequency of Measles in Infants Younger than 9 Months of Age. *Journal of Medical Sciences*, *26*(2), 115-119. https://jmedsci.com/index.php/Jmedsci/article/view/534
8. World Health Organization. (2025). Measles. Fact sheet. Geneva: WHO.
9. Mathis, A. D. (2025). Measles update—United States, january 1–april 17, 2025. *MMWR. Morbidity and Mortality Weekly Report*, *74*.
10. Ong, D. S., Von Mollendorf, C., Mulholland, K., & Do, L. A. (2025). Measles Seroprevalence in infants under 9 months of age in low- and middle-income countries: A systematic review and meta-analysis. *The Journal of Infectious Diseases*. https://doi.org/10.1093/infdis/jiaf177
11. Tiley, K. S., Ten Hulscher-van Overbeek, H., Basnet, S., van Binnendijk, R., Clarke, E., Cose, S., ... & Voysey, M. (2025). The waning of maternal measles antibodies: a multi-country maternal-infant seroprevalence study. *Journal of Infection*, 106531. https://doi.org/10.1016/j.jinf.2025.106531
12. Filia, A., Del Manso, M., Petrone, D., Magurano, F., Gioacchini, S., Pezzotti, P., Palamara, A. T., & Bella, A. (2025). Surge in measles cases in Italy from August 2023 to January 2025: Characteristics of cases and public health relevance. *Vaccines*, *13*(7), 663. https://doi.org/10.3390/vaccines13070663
13. Centers for Disease Control and Prevention. Measles Cases and Outbreaks. Atlanta: CDC; 2025 [updated 2025 Dec 30].
14. Goult, E., Barrero Guevara, L. A., Briga, M., & Domenech de Cellès, M. (2024). Estimating the optimal age for infant measles vaccination. *Nature Communications*, *15*(1). https://doi.org/10.1038/s41467-024-53415-x
15. Varma, A., Bolotin, S., De Serres, G., Didierlaurent, A. M., Earle, K., Frey, K., Hahné, S., Kapelus, D., Krause, L. K., McCarthy, K., Moss, W. J., Orenstein, W. A., Van Binnendijk, R., Vittrup, D. M., Voysey, M., Woudenberg, T., Bar-Zeev, N., Bose, A. S., Hombach, J., ... Crowcroft, N. S. (2025). What is the current evidence base for measles vaccination earlier than 9 months of age?: Report from an informal technical consultation of the World Health Organization. *Vaccine*, *57*, 127187. https://doi.org/10.1016/j.vaccine.2025.127187