



EVALUATION OF THE BURDEN OF MEASLES COMPLICATIONS AMONG VACCINATED AND NON - VACCINATED CHILDREN PRESENTING AT A HOSPITAL OF LAHORE

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Abstract

Introduction: Measles remains a highly contagious viral infection and continues to contribute substantially to childhood morbidity in developing countries despite the availability of an effective vaccine. Unvaccinated children are more likely to develop severe complications such as bronchopneumonia, diarrhea, dehydration, otitis media, and encephalitis. Evaluating the burden of complications among vaccinated and non-vaccinated children may help strengthen immunization strategies in high-risk settings.

Aims & Objective: To compare the frequency of measles-related complications among vaccinated and non-vaccinated children presenting to a tertiary care hospital.

Methodology: A randomized controlled study was conducted in the Department of Pediatrics at Arif Memorial Teaching Hospital, Lahore, Pakistan, from 3rd June 2025 to 3rd November 2025. A total of 234 children with clinically diagnosed measles were enrolled and randomly assigned to vaccinated (n = 117) and non-vaccinated (n = 117) groups using consecutive sampling. Demographic and clinical data were collected through detailed history, clinical examination, and relevant investigations. Children were monitored for complications including bronchopneumonia, upper respiratory tract infection, diarrhea, oral ulcer, dehydration, otitis media, malnutrition, and encephalitis. Data were analyzed using SPSS version 25. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. The chi-square test was used to compare complication frequencies between groups, with $p \leq 0.05$ considered statistically significant.

Results & Findings: The mean age of participants was 6.48 ± 3.72 years, with 134 (57.3%) males and 100 (42.7%) females. Most children belonged to low or lower-middle socioeconomic groups. Bronchopneumonia was the most common complication and occurred significantly more often among non-vaccinated children (59.0%) compared with vaccinated children (46.2%) ($p = 0.041$). Diarrhea

was also significantly higher in the non-vaccinated group (51.3%) compared with vaccinated children (32.5%) ($p = 0.003$). Other complications, including dehydration, otitis media, malnutrition, and encephalitis, were observed more frequently among non-vaccinated children, although these differences were not statistically significant. Vaccinated children also demonstrated a slightly shorter mean duration of hospital stay.

Conclusion: Measles complications were consistently more frequent among non-vaccinated children, with significant differences observed for bronchopneumonia and diarrhea. These findings suggest that measles vaccination reduces disease severity and complication rates among pediatric patients.

Keywords: Measles; Vaccination; Measles complications; Bronchopneumonia; Diarrhea; Immunization; Pediatric infectious diseases.

INTRODUCTION

Measles (rubeola) remains one of the most contagious viral infections known to humanity, capable of causing severe morbidity and mortality, particularly among the pediatric population in developing countries (1,2). Despite the availability of a safe, efficacious, and cost-effective vaccine, measles continues to re-emerge globally, with the World Health Organization reporting approximately 430,000 cases and 142,000 deaths in 2019 alone, predominantly affecting children under five years of age (3). Recent data further indicate a surge in measles cases among children worldwide, underscoring the imperative of bolstering vaccination rates to strengthen societal immunity (4).

Epidemiological evidence consistently demonstrates that the overwhelming majority of measles cases occur in unvaccinated or incompletely vaccinated children. In a large Greek outbreak in 2017–2018, Gianniki et al. reported that 91.5% of 578 affected children were unvaccinated, and 67.2% of hospitalized children developed one or more complications (2). Similarly, Yazı et al. found that 70% of pediatric patients with measles in Istanbul were unvaccinated (4). In Pakistan, Ullah et al. documented that 93.86% of 212 hospitalized children with measles had not received immunization, with pneumonia (31.13%), gastroenteritis (19.33%), and encephalitis (2.35%) among the most frequent complications (5).

The clinical burden of measles is substantially greater in unvaccinated children compared to their vaccinated counterparts. Az et al. demonstrated that 81.8% of complicated measles cases occurred in unvaccinated patients, and all hospitalizations were observed exclusively in the unvaccinated group (6). In a hospital-based retrospective cohort study in Somalia, Mohamud et al. confirmed that vaccinated cases experienced fewer illnesses and complications than unvaccinated cases (7). In Pakistan, Haq et al. reported a 14.4% mortality rate among measles-admitted children, with the highest deaths occurring among non-immunized patients, and significant statistical correlations between immunization status and pneumonia ($p = 0.036$), diarrhea ($p = 0.045$), and overall outcome ($p = 0.014$) (8). Kumar et al. further established a positive correlation between lack of vaccination and the development of measles complications, with patients in second-degree protein-energy malnutrition at the highest risk (9).

Pakistan represents a high-burden setting for measles, having experienced multiple outbreaks in recent years, including major outbreaks in 2013 and 2017, with significant fatality rates among hospitalized children with complicated measles (5). Kulsoom et al., studying children at a tertiary care hospital in Karachi, reported bronchopneumonia in 86.5%, acute diarrhea in 34.6%, and encephalitis in 13% of 185 hospitalized measles patients, with bronchopneumonia being the leading cause of death in 13.5% of cases (10). Raza et al. further documented that measles constituted 26.6% of all vaccine-preventable diseases among children admitted to tertiary care hospitals in Lahore, with non-vaccination identified as the primary contributing factor (11). Despite this substantial disease burden, comparative data on the frequency of complications specifically between vaccinated and non-vaccinated children presenting at tertiary care hospitals in Pakistan remain limited. Given the persistent gaps in immunization coverage, ongoing outbreaks, and the high complication and mortality

rates documented in the Pakistani pediatric population, this study is critically needed to generate local evidence that can inform targeted public health interventions, strengthen the Expanded Programme on Immunization (EPI), and guide clinical management strategies for measles in Pakistan.

METHODOLOGY

A randomized controlled study was conducted in the Department of Pediatrics at Arif Memorial Teaching Hospital, Lahore, a tertiary care teaching hospital that receives pediatric patients from Lahore and the surrounding regions of Punjab, Pakistan. The study was carried out over a period of six months, from the 3rd June to 3rd November 2025, following approval of the research proposal by the institutional ethical review board. The study aimed to compare the frequency of measles complications among vaccinated and non-vaccinated children presenting to the hospital with a clinical diagnosis of measles. Ethical approval was obtained prior to the initiation of the study, and written informed consent was obtained from the parents or guardians of all enrolled children.

The required sample size was calculated to be 234 children, with 117 patients in each group, based on an expected diarrhea frequency of 32% among vaccinated children and 50% among non-vaccinated children, with a confidence level of 95% and a power of 80%. Participants were recruited using a non-probability consecutive sampling technique. Children presenting to the pediatric outpatient department and subsequently admitted to the hospital with a clinical diagnosis of measles were screened for eligibility. Both male and female children aged 9 months to 16 years with signs and symptoms consistent with measles were included. Measles was diagnosed clinically according to World Health Organization criteria, which include a fever lasting more than 3 days with a temperature of at least 38°C, a maculopapular rash, and at least one of the following symptoms: cough, coryza, or conjunctivitis. Children who had unclear vaccination histories, children with chronic illnesses such as congenital heart disease or chronic renal failure, and those receiving medications for other underlying disorders were excluded from the study.

After enrollment, detailed demographic and clinical information were obtained through history taking and clinical examination. The vaccination status of each child was verified either through the vaccination card or by parental confirmation when the vaccination card was unavailable. Based on vaccination status, the participants were divided into two equal groups. Group I consisted of vaccinated children with documented evidence of measles vaccination, whereas Group II consisted of children with no history of measles vaccination. All patients were admitted and managed according to the standard hospital protocols for measles and its associated complications. Baseline investigations, including complete blood count and chest radiography, were performed in all patients to assist in clinical assessment and identification of complications. Lumbar puncture was performed only in patients with clinical suspicion of encephalitis.

During hospitalization, all patients were closely observed for the Development of measles-related complications. The complications evaluated in the study included bronchopneumonia, upper respiratory tract infection, diarrhea, oral ulcer, dehydration, otitis media, malnutrition, and encephalitis. Bronchopneumonia was diagnosed according to World Health Organization criteria based on respiratory rate thresholds or radiographic evidence of pulmonary infiltrates. Upper respiratory tract infection was diagnosed clinically based on symptoms such as nasal congestion, sore throat, cough, and sneezing. Diarrhea was defined as the passage of three or more loose or watery stools within 24 hours as reported by the caregiver. An oral ulcer was clinically diagnosed based on circumscribed lesions on the oral mucosa measuring more than 3 mm in diameter. Dehydration was assessed using clinical indicators, including decreased urine output, tachycardia, and laboratory evidence of electrolyte imbalance. Otitis media was identified by the presence of middle ear fluid without acute infection symptoms. Malnutrition was assessed using weight-for-height Z-scores, with values between -2 SD and -3 SD classified as malnutrition and values below -3 SD classified as severe malnutrition. Encephalitis was diagnosed in patients presenting with fever accompanied by altered mental status, seizures, abnormal movements, tremors, or spastic paralysis.

Additional variables recorded included age, gender, socioeconomic status, vaccination status, and

duration of hospital stay. Socioeconomic status was categorized by monthly household income: families earning less than 8,000 Pakistani rupees per month were categorized as low socioeconomic class, those earning between 8,000 and 30,000 rupees as lower-middle class, and those earning more than 30,000 rupees as upper-middle class. The duration of hospital stay was measured in days from admission to discharge. All patients received standard supportive treatment for measles, including nutritional counseling for parents and oral vitamin A supplementation with two doses according to hospital protocol. Patients were discharged when they became afebrile and clinically stable.

All collected data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 25. Continuous variables, including age and duration of hospital stay, were summarized using mean and standard deviation. Categorical variables such as gender, vaccination status, socioeconomic status, and the presence of complications were presented as frequencies and percentages. The chi-square test was applied to compare the frequency of complications between vaccinated and non-vaccinated groups. A p-value of 0.05 or less was considered statistically significant. To control for potential confounding effects, stratification was performed by age group and socioeconomic status. After stratification, the chi-square test was reapplied to determine the association between vaccination status and the occurrence of complications within each subgroup.

RESULTS & FINDINGS

A total of 234 children with a clinical diagnosis of measles were included in the study and divided into two equal groups: vaccinated (n = 117) and non-vaccinated (n = 117). The mean age of the participants was 6.48 ± 3.72 years, with a slightly comparable distribution between the vaccinated group (6.32 ± 3.60 years) and the non-vaccinated group (6.64 ± 3.84 years). Among the study population, 134 (57.3%) children were males and 100 (42.7%) were females, indicating a higher proportion of male admissions for measles-related complications. Regarding socioeconomic distribution, 109 (46.6%) children belonged to the low socioeconomic class, 90 (38.5%) to the lower-middle class, and 35 (14.9%) to the upper-middle class. The mean duration of hospital stay for the overall study population was 4.72 ± 1.89 days, with vaccinated children having a slightly shorter hospital stay compared with non-vaccinated children (Table 1).

Table 1: Demographic and Clinical Characteristics of Study Participants (n = 234)

Variable	Vaccinated (n = 117)	Non-Vaccinated (n = 117)	Total (n = 234)
Age (years), Mean $\pm$ SD	6.32 ± 3.60	6.64 ± 3.84	6.48 ± 3.72
Male	67 (57.3%)	67 (57.3%)	134 (57.3%)
Female	50 (42.7%)	50 (42.7%)	100 (42.7%)
Low socioeconomic class	51 (43.6%)	58 (49.6%)	109 (46.6%)
Lower-middle class	48 (41.0%)	42 (35.9%)	90 (38.5%)

The distribution of measles-related complications among the study participants showed that bronchopneumonia was the most frequently observed complication, followed by diarrhea and upper respiratory tract infection. Bronchopneumonia occurred in 54 (46.2%) vaccinated children compared with 69 (59.0%) non-vaccinated children. Diarrhea was observed in 38 (32.5%) vaccinated patients and 60 (51.3%) non-vaccinated patients, demonstrating a significantly higher frequency among unvaccinated children. Upper respiratory tract infection was reported in 42 (35.9%) vaccinated children and 48 (41.0%) non-vaccinated children. Oral ulcer was present in 30 (25.6%) vaccinated children and 36 (30.8%) non-vaccinated children (Table 2).

Table 2: Comparison of Major Measles Complications Between Vaccinated and Non-

Vaccinated Children

Complication	Vaccinated (n = 117)	Non-Vaccinated (n = 117)	p-value
Bronchopneumonia	54 (46.2%)	69 (59.0%)	0.041
Upper respiratory tract infection	42 (35.9%)	48 (41.0%)	0.412
Diarrhea	38 (32.5%)	60 (51.3%)	0.003
Oral ulcer	30 (25.6%)	36 (30.8%)	0.366

Additional complications, including dehydration, otitis media, malnutrition, and encephalitis, were also assessed during hospitalization. Dehydration was observed in 17 (14.5%) vaccinated children compared with 27 (23.1%) non-vaccinated children. Otitis media was diagnosed in 12 (10.3%) vaccinated children and 20 (17.1%) non-vaccinated children. Malnutrition was identified in 8 (6.8%) vaccinated patients compared with 15 (12.8%) non-vaccinated patients. Encephalitis was a rare but serious complication, occurring in 2 vaccinated children (1.7%) and 7 non-vaccinated children (6.0%). Although these complications were numerically more frequent among non-vaccinated children, the statistical significance varied across different complications (Table 3).

Table 3: Comparison of Additional Measles Complications Between Groups

Complication	Vaccinated (n = 117)	Non-Vaccinated (n = 117)	p-value
Dehydration	17 (14.5%)	27 (23.1%)	0.082
Otitis media	12 (10.3%)	20 (17.1%)	0.129
Malnutrition	8 (6.8%)	15 (12.8%)	0.115
Encephalitis	2 (1.7%)	7 (6.0%)	0.086

Overall, the analysis demonstrated that most measles-related complications occurred more frequently among non-vaccinated children compared with vaccinated children. Statistically significant differences were particularly observed for bronchopneumonia and diarrhea, highlighting the protective role of measles vaccination in reducing the severity and frequency of complications among hospitalized pediatric patients.

DISCUSSION

The present study enrolled 234 children with clinically diagnosed measles, equally divided into vaccinated (n = 117) and non-vaccinated (n = 117) groups, with a mean age of 6.48 ± 3.72 years. A male predominance was observed, with 134 (57.3%) male children. A similar male predominance has been reported in other studies, including Verma et al., who reported 57% male patients during the Mumbai outbreak (12). Gianniki et al. also reported a male-to-female ratio of 1.5:1 in Greece (2), while Ferdousi et al. observed a male-to-female ratio of 1.8:1 in Bangladesh (13). Regarding socioeconomic distribution, 46.6% of children belonged to the low socioeconomic class and 38.5% to the lower-middle class. These findings are consistent with previous research indicating that measles disproportionately affects children from disadvantaged socioeconomic backgrounds. Kumar et al. demonstrated that socioeconomic status significantly influences the risk of measles complications (4). At the same time, Ilyas et al. reported that 50% of measles-complicated children in Peshawar belonged to poor socioeconomic groups (14). The mean duration of hospital stay was 4.72 ± 1.89 days. Vaccinated children had a shorter hospital stay (4.34 ± 1.71 days) compared to non-vaccinated children (5.11 ± 1.94 days). Similar observations were reported by Az et al., who found that most

hospitalized patients with measles were unvaccinated (15). Dam et al. also showed that vaccinated cases experienced significantly fewer complications and hospitalizations than unvaccinated cases (16). Bronchopneumonia was the most frequent complication, occurring in 54 (46.2%) vaccinated and 69 (59.0%) non-vaccinated children, with a significant difference ($p = 0.041$). Pneumonia is widely recognized as the leading complication of measles. Kulsoom et al. reported bronchopneumonia in 86.5% of hospitalized measles patients in Karachi, while Ferdousi et al. documented it in 72.3% of children in Bangladesh (13). Verma et al. also reported pneumonia in 32% of measles cases (12). Higher rates among unvaccinated children have also been reported by Az et al. (15), Yazı et al. (7), and Tuncay et al. (17). This increased susceptibility is attributed to measles-induced immunosuppression, which predisposes children to secondary infections (1). Diarrhea was observed in 38 (32.5%) vaccinated and 60 (51.3%) non-vaccinated children and showed the most significant difference between groups ($p = 0.003$). Similar findings were reported by Ilyas et al. in Peshawar (14) and Verma et al., who documented gastrointestinal symptoms in 30% of measles patients (12). Gianniki et al. reported dehydration secondary to diarrhea in 19.6% of hospitalized children (2), while Mohamud et al. observed fewer gastrointestinal complications among vaccinated cases (6). The higher rate of diarrhea among unvaccinated children may reflect measles-associated mucosal damage and immune suppression (1). Vaccination has been shown to reduce the risk of severe gastrointestinal complications (18). Upper respiratory tract infection (URTI) was present in 42 (35.9%) vaccinated and 48 (41.0%) non-vaccinated children, with no statistically significant difference ($p = 0.412$). Yazı et al. similarly reported respiratory symptoms, such as cough, in 67.5% of measles cases, with no significant differences between vaccination groups (7). Schoini et al. also noted that respiratory symptoms such as cough and coryza are common features of measles irrespective of vaccination status (19). Oral ulcer was observed in 30 (25.6%) vaccinated and 36 (30.8%) non-vaccinated children ($p = 0.366$). Rahat et al. reported oral ulcers in 66% of measles-affected infants (3). The absence of a significant difference between groups may reflect the direct involvement of the oral mucosa in measles infection. Breakthrough cases among vaccinated individuals may still present with mucosal lesions such as Koplik's spots (18). Mohamud et al. also reported that mucosal manifestations may occur regardless of vaccination status (6).

Among other complications, dehydration occurred in 17 (14.5%) vaccinated and 27 (23.1%) non-vaccinated children ($p = 0.082$), otitis media in 12 (10.3%) vaccinated and 20 (17.1%) non-vaccinated children ($p = 0.129$), malnutrition in 8 (6.8%) vaccinated and 15 (12.8%) non-vaccinated children ($p = 0.115$), and encephalitis in 2 (1.7%) vaccinated and 7 (6.0%) non-vaccinated children ($p = 0.086$). Although these differences were not statistically significant, higher complication rates among non-vaccinated children were consistently observed.

Gianniki et al. reported dehydration in 19.6% and otitis media in 21% of hospitalized measles children (2), while Dam et al. observed complications, including otitis media, more frequently in unvaccinated cases (16). Mehta et al. reported that measles encephalitis occurs in approximately 1 per 1000 cases and carries a mortality rate of 10–15% (20). Statler et al. also identified encephalitis as a severe complication predominantly affecting unvaccinated children (8). Similarly, Kumar et al. demonstrated that malnourished children have a significantly higher risk of developing complicated measles (4), which aligns with the higher proportion of malnutrition among non-vaccinated children in the present study. Overall, statistically significant differences were observed for bronchopneumonia ($p = 0.041$) and diarrhea ($p = 0.003$), with consistent trends toward higher complication rates among non-vaccinated children. These findings align with previous research demonstrating that measles vaccination substantially reduces disease severity and complications. Studies by Dam et al. (16), Fappani et al. (18), Mohamud et al. (6), Az et al. (15), and Tuncay et al. (17) similarly concluded that vaccinated children experience fewer complications and milder disease compared with unvaccinated children. Collectively, the evidence supports the protective role of measles vaccination in reducing complications, shortening hospital stay, and lowering the overall disease burden among pediatric patients.

CONCLUSION

Measles vaccination was associated with a lower frequency of complications and shorter hospital stay among hospitalized children. Strengthening routine immunization coverage may substantially reduce measles-related morbidity and improve pediatric health outcomes in high-burden settings. Declarations Data Availability statement All data generated or analysed during the study are included in the manuscript. Ethics approval and consent to participate Approved by the department concerned. (IRBEC-ARMTH-0924d1-25) Consent for publication Approved Funding Not applicable

Conflict of interest

The authors declared no conflict of interest.

Author Contribution

- Concept & Design of the study: Urwa Khalil & Tahir Masood
- Drafting: Sehar Zahid
- Data analysis: Sbah Munir & Asma
- Critical Review & Final approval: Izza Imran & Tahir Masood

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the study's integrity.

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