Original Article

Iraqi National Journal of Medicine. January 2026, Volume 8, Issue 1

Measles Outbreak in Anbar Province During 2023-2024. Demographic Distribution and Vaccination Status

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ABSTRACT

Background: This is the first public study covering all cities in Anbar Province regarding the measles outbreaks occurred in 2023 and 2024. **Aim**: To estimate the demographic distribution of measles among infected children (age, gender, residence) in Anbar Province and to study the effectiveness of the measles vaccine for each patient on infection. **Methods**: A retrospective analytic cross-sectional study was conducted across all sectors of Anbar Province. The patients included those who were admitted, diagnosed, and treated in various hospitals during the measles outbreak in 2023, and 2024 years. The data was recorded in files of the Anbar Public Health Directorate, which included information on age, gender, residence, clinical manifestations, and vaccination status for each patient. **Results**: A total of 1,663 cases was 1663 patients with a male-to-female ratio of 1.2:1. Among the patients, 203 (12.2%) were less than one year old, 595 (35.8%) were between one to two years old, and 865 (52%)were more than two years. Of the cases, 259 (15.6%) were unvaccinated, 944 (56.8%) had received single dose of the measles vaccine, and 460 (27.6%) had received two or more doses. The most commonly reported clinical features were fever, skin rash, conjunctivitis, coryza, and cough, while lymphadenopathy was the least reported. **Conclusions**: A high percentage of cases were diagnosed with measles in Anbar Province, and a significant number of patients contracted the infection despite being vaccinated.

Keywords: Measles, age, gender, vaccination status, Anbar province.

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Disclaimer: The authors declare no conflict of interest.

DOI: https://doi.org/10.37319/iqnjm.8.1.2

Received: 6 SEP 2025 Accepted: 20 DEC 2025 Published online: 15 JAN 2026

INTRODUCTION

Measles, a highly contagious viral infection caused by an RNA virus, belongs to the Paramyxoviridae family.[1] Measles is considered a significant public health problem, as the virus can be transmitted through droplets or aerosols, leading systemic infection.[2] it contributes to both child mortality and morbidity worldwide, accounting for approximately 4% of the annual six million deaths among children under five years of age.[3] Despite the availability of an effective and safe attenuated live measles virus vaccine, measles remains a dangerous disease globally. In Iraq, public primary healthcare centers provide essential, free-of-charge vaccines to all individuals.[4] The standard immunization schedule to achieve herd immunity

includes a single dose of the measles vaccine at nine months of age, followed by two doses of the mumps, measles, and rubella (MMR) vaccine administered at 18 and 24 months of age. However, outbreaks of measles continue to pose a significant global public health concern.[5-7] The disease is vaccine-preventable, with an incubation period of 7–21 days. Measles symptoms progress through a prodromal phase characterized by fever, cough, coryza, and conjunctivitis, followed by a distinctive rash that typically appears on day five. Complications such as diarrhea, otitis media, pneumonia, and encephalitis can occur, particularly in malnourished children and individuals with weakened immune systems.[8,9] The main objectives of this study were:

1. To estimate the demographic distribution of measles in Anbar Province, including gender, age, and regional distribution of cases.
2. To study the effectiveness of the measles vaccine on the emergence of infection.
3. To identify the most prominent clinical manifestations of the disease.

MATERIALS AND METHODS

Study Design: A retrospective cross-sectional analytic study was conducted using data collected from each patient file. The data were analyzed based on different ages, genders, regional distribution, clinical manifestations, and vaccination status for each patient.

Study Setting and Period: The study was based on files of patients diagnosed and treated for measles, both clinically and in the laboratory. The study period spanned two months from June 1, 2025, to August 1, 2025. All cases studied were from patients admitted to various hospitals in Anbar Province. Diagnosis was based on clinical signs and symptoms of measles (fever, cough, coryza, skin rash, and conjunctivitis), and a throat swab was taken from all studied cases and sent to public health laboratories for virus detection to confirm the diagnosis. Ethical Considerations: Patient files were obtained from the Anbar Public Health Directorate in Anbar Governorate, Iraq. Permission to access the files was granted by the director of public health, with a commitment to maintain participant confidentiality and to delete the files after completing the study. Ethical approval for this study was obtained from the Anbar Research Committee Data Collection: Data were collected in a specially prepared questionnaire for each patient, which included:

1. Name
2. Gender
3. Age, categorized into three groups:less than one year, one to two years, and older than two years.
4. Vaccination status for each patient, indicating whether the patient was unvaccinated, received a single dose of the vaccine, or received two or more doses.
5. Clinical manifestations, including fever, rash, cough, coryza, conjunctivitis, diarrhea, and lymphadenopathy.
6. Residence, among different cities in Anbar province.

Inclusion and Exclusion Criteria:

Inclusion Criteria: The study included all reported measles cases in Anbar Province during 2023 and 2024.

Exclusion Criteria:

1. Patients with incomplete data.
2. Unconfirmed diagnoses.

Data Analysis: A Chi-square (X^2) test was performed on all data to assess the relationship between gender and different age group intervals with the vaccination status of patients, using the Statistical Package for Social Sciences (SPSS) Version 26.0. Differences were considered significant when $P \leq 0.05$.

RESULTS

The total number of recorded cases during the two-year measles outbreak in Anbar Province was 1,663 patients, with boys accounting for 911 (54.8%) of cases, slightly more than girls who accounted for 752 (45.2%), resulting in 752 (45.2%)a ratio of 1.2:1. Among the age groups, the least number of cases was found in children under one year (203, 12.2%), while 203 (12.2%) .595 (35.8%)the highest number was among children older than two years (865, 52%). 865 (52%) As shown in Tables 1, and 2.

The vaccination status of infected children in this study indicated that 259(15.6%) were unvaccinated, 944 (56.8%) had received a single dose of the measles vaccine, and 460 (27.6%) had received two or more doses.The distribution of cases among different cities in Anbar Province showed that measles infections were widespread throughout the province, with the highest number of cases diagnosed in larger cities (Ramadi, Fallujah, and Qaim) (Table 3).

Clinical manifestations recorded from diagnosed cases showed that fever and skin rash were present in 100% of cases, conjunctivitis in 95%, coryza in 92%, cough in 88%, diarrhea in 9%, and lymphadenopathy in 4% (Fig. 1).

Table 1: Distribution of vaccination status by gender

Gender	No vaccine	One dose vaccine	Two or more doses	Total
Boys	141	503	267	911(54.8%)
Girls	118	441	193	752(45.2%)
Total	259 (15.6%)	944 (56.8%)	460 (27.6%)	1663
P-value among different genders is not significant (P > 0.05)				

Table 2: Distribution of vaccination status by age

Age	No vaccine	One dose vaccine	Two or more doses	Total
<1 Year	48	78	77	203(12.2%)
1-2 Years	90	316	189	595(35.8%)
>2 Years	121	550	194	865(52%)
Total	259(15.6%)	944(56.8%)	460(27.6%)	1663
P-value among different age groups is significant (P ≤ 0.05)				

Table 3: Distribution of cases among all governorate cities

City	Measles
Ramadi	276
Fallujah	255
Aameriah	72
Karmah	135
Heet	139
Anah	27
Rawah	24
Hadithah	83
Saghlawiah	36
Baghdadi	84
Rutbah	146
Khalidiah	150
Obiadi	33
Qaim	203
Total	1663

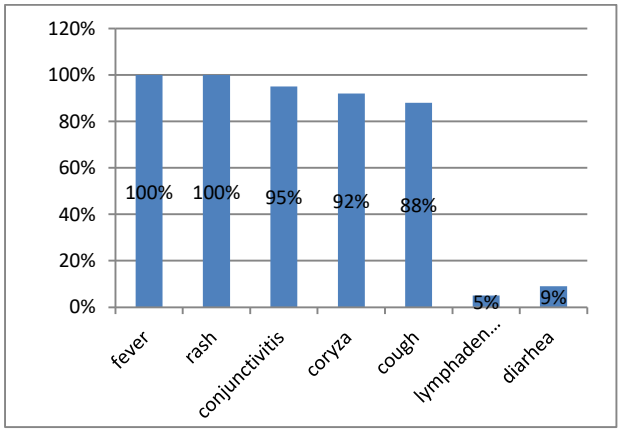

Figure 1: Clinical manifestation of patients

DISCUSSION

Despite the availability and safety of cost-effective vaccines, significant measles outbreaks continue to occur worldwide. In 2022, it was estimated that approximately 136,000 measles-related deaths occurred globally, predominantly among young children under five years of age. [10] This study is part of a series of investigations into the prevalence and demographic distribution of infectious diseases in Anbar Province, including brucellosis.[11,12] and kala-azar. The study included only admitted cases; thus, the actual number of measles infections during the 2023-2024 outbreak is likely higher, as many cases were treated as outpatients, and also the biggest number were managed in private clinics. Efforts are recommended by the Ministry of Health to record any infectious diseases treated in private clinics in cooperation with the Iraqi Doctors Syndicate and private hospitals. In this study, boys were reported slightly more than girls, with a ratio of 1.2:1. While the measles virus does not exhibit a specific preference for one sex over the other in terms of infection, some studies suggest that males may have slightly higher incidence rates in certain age groups. Research conducted in India and England supports these findings.[13,14] The exact mechanisms underlying the higher incidence rates in males remain unclear and are likely multifactorial, including differences in exposure, vaccine response, and genetic and hormonal factors. A study in Spain found that females develop significantly higher measles IgG titers following vaccination compared to age-matched males. There is evidence suggesting a weaker antibody response to the measles vaccine in boys.[15], while females exhibit.[16] a higher humeral antibody response to the live measles vaccine. Additionally, females appear to experience less waning immunity to the measles vaccine.[17,18] Consequently, even after immunization, males may be more susceptible to measles than females. In this study, the majority of reported cases were among children older than two years, with fewer cases in those under one year. Another study in India.[19] also showed the peak of measles infection among children aged 2-3 years. However, various studies showed that measles infections are often reported more frequently among older children, while some research indicate that measles is predominantly diagnosed at lower than 5 years. These discrepancies primarily depend on the vaccination status of the communities, sample size, and

the percentage coverage of the measles vaccine. In our study, there was an increase in cases among infants despite the passive immunity they received from their mothers. Infants typically rely on maternal antibodies for protection in their early months; however, waning maternal immunity in populations with high vaccine-derived immunity may leave this age group vulnerable. Other reasons.[20,21] may include missed vaccinations among mothers during their childhood. Furthermore, an increasing rate of measles infection among older age groups (>15 years) is also anticipated, as they may have missed routine vaccinations or experienced waning immunity, making them more susceptible during outbreaks. Therefore, it is recommended.[22] to re-vaccinate these target groups, as many may not have been vaccinated or may have diminished immunity over time. Regarding the vaccination status of infected children, a high percentage of our cases were unvaccinated, necessitating efforts from television programs and health centers to educate families about the benefits of vaccination against measles. However, more than half of our studied patients had received a single vaccine, and a significant percentage of cases were vaccinated with two or more vaccines. A study in Saudi Arabia indicated[23] that vaccinated children (43.34%) contracted measles compared to 67.4% of unvaccinated children. In another study in Pakistan.[24] only 73.48% of vaccinated children developed a humeral immune response as detected through ELISA after blood samples were taken from both vaccinated and unvaccinated children. In Iraq, several factors may contribute to decreased vaccination rates, including fear of vaccination and uneducated families regarding vaccination.[25] Other factors that may reduce vaccine efficacy include improper storage, inadequate transportation methods, or poor vaccine delivery to health centers. Efforts should be made to address these possible reasons and treat them by training special staff. Another study on the prevalence of measles infection among vaccinated and unvaccinated children is recommended. During the COVID-19 pandemic, there was a decline in vaccination coverage, including among children, which may explain the outbreak of measles in 2023. A study in Iraq reported a decrease in vaccination coverage from 83.7% in 2018 to 63.6%in 2020.[26]

Clinical manifestations of measles recorded in this study indicated that fever, skin rash, conjunctivitis, cough, and coryza were the most prominent signs and symptoms, while lymphadenopathy was the least reported. However, another study in Iraq.[27] reported that fever and maculopapular rash were nearly universal, occurring in 99.7% and 99.4% of cases, respectively. Cough was reported in 87% of cases, coryza in 72.3%, conjunctivitis in 45.1%, and lymphadenopathy in 22.1%. Most studies indicate that the characteristic clinical manifestations of measles, such as fever, cough, runny nose, conjunctivitis, Koplik spots, and rash, are often sufficient to suspect measles; laboratory investigations are typically needed only to confirm the diagnosis.[28]

This study has several limitations. Firstly, it was a retrospective analysis of hospitalized patients, which does not capture measles cases managed in outpatient settings or those who did not seek medical care. Therefore, our results apply only to hospitalized pediatric cases and may not represent the full spectrum of measles severity in the community. Additionally, cases treated in private healthcare facilities were not included, which may limit the generalizability of our findings.

CONCLUSIONS

In summary, there were 1,663 diagnosed patients with measles during the outbreak of 2023-2024. The male-to-female ratio was 1.2:1, with most cases occurring in children older than two years. Approximately 15% of diagnosed cases were unvaccinated, while more than half of the patients had received single-dose vaccine. A new study examining the efficacy of measles vaccines in older children is recommended. Additionally, health centers should conduct sessions to encourage families to vaccinate their children.

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