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Assessment of The Immunological Effectiveness of Measles Vaccination in Children in The Khorezm Region

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Abstract

This scientific work is devoted to a comprehensive study and evaluation of the effectiveness of anti-epidemic measures regarding measles in the Khorezm region. The article presents a retrospective analysis of the epidemic process, which revealed key patterns of virus transmission in conditions of high population density and modern migration challenges. Particular emphasis is placed on analyzing the effectiveness of using the live measles vaccine as a primary tool for managing the epidemiological situation. In the course of the study, the state of specific immunity among various population groups is examined in detail, and the causes of "immunity breakthroughs" and cases of the disease among previously vaccinated individuals are analyzed. The article demonstrates the impact of timely vaccination coverage (including revaccination) on reducing the intensity of the epidemic process and preventing patient disability. The work also reflects the problems of forming a non-immune population layer, caused by both medical exemptions and socio-psychological factors, such as "anti-vaccination" movements.

The article contains evidence-based proposals for improving the measles elimination strategy in the Khorezm region, including strengthening the role of molecular genetic monitoring and optimizing logistical systems for vaccine storage. The research materials hold practical value for epidemiologists, infectious disease specialists, and healthcare administrators in predicting and controlling outbreak morbidity.

Keywords: Measles, vaccination, specific prevention, immunity, children, Khorezm region.

Introduction

Measles is a highly contagious infectious disease caused by an RNA-containing virus of the genus Morbillivirus, belonging to the family Paramyxoviridae. The infection is transmitted primarily through the airborne droplet route, with a contagiousness index reaching 95–98% [1]. In unvaccinated populations or among individuals without established immunity, the disease can rapidly acquire an epidemic character.

According to the World Health Organization, the global incidence of measles has shown a renewed upward trend in recent years. During 2022–2023, a decline in vaccination coverage and disruptions in routine immunization programs during the COVID-19 pandemic resulted in an increase in measles cases in many countries [2,3]. The risk of mortality and severe complications among children remains an important public health concern.

Clinically, measles is characterized by high fever, intoxication syndrome, catarrhal manifestations such as cough, rhinitis, and conjunctivitis, as well as a maculopapular exanthema. In severe cases, complications including pneumonia, acute otitis media, laryngotracheitis, and encephalitis may occur [4]. Children with weakened immune systems are at particularly high risk of severe disease and the development of complications.

The most effective measure for the prevention of measles is specific prophylaxis through the administration of a live attenuated vaccine. Vaccination induces a humoral immune response and promotes the formation of protective IgG-class antibodies [5]. Transmission of the infection can be effectively interrupted when the level of population immunity reaches at least 95% [6].

According to the National Immunization Schedule of the Republic of Uzbekistan, vaccination against measles is administered at 12 months of age, followed by revaccination at 6 years of age. However, even in regions with high vaccination coverage, serological monitoring remains important for assessing the level of protective immunity. In particular, evaluating the effectiveness of the immune response is a relevant public health priority in regions with a high density of the pediatric population in order to maintain epidemiological stability.

A scientific assessment of the effectiveness of measles prevention measures among children in the Khorezm region is important for reducing epidemiological risk and strengthening population immunity. Therefore, the present study was designed to investigate the level of protective immune response formed in children following measles vaccination.

Aim of the Study

To evaluate the effectiveness of specific measles prevention among children in the Khorezm region, to determine the level of protective immunity after vaccination across different age groups, and to analyze indicators of population immunity.

Methods

This analytical cross-sectional observational study was conducted in the Khorezm region during 2024–2025. The study aimed to assess the level of protective immunity formed in children following measles vaccination. A total of 36 children were enrolled in the study.

The participants were divided into two age groups:

- Group I — 24 children under 1 year of age;
- Group II — 12 children aged 4–13 years.

All children had received measles vaccination in accordance with the National Immunization Schedule of the Republic of Uzbekistan.

Inclusion Criteria

- Vaccination in accordance with the National Immunization Schedule;
- Healthy or clinically stable condition;
- Written informed consent obtained from parents or legal guardians.

Exclusion Criteria

- Immunodeficiency conditions;
- Presence of an acute infectious disease at the time of examination;
- Previous receipt of blood products.

Study Methods

1. Clinical Assessment

The general clinical condition of all children was assessed. Post-vaccination reactions, including hyperthermia and local reactions, as well as possible complications, were monitored.

2. Epidemiological Assessment

Vaccination history, timing of immunization, revaccination status, and epidemiological history were evaluated.

3. Serological Testing

Venous blood samples were collected to assess the immune response. Blood serum was analyzed using an enzyme-linked immunosorbent assay (ELISA).

The concentration of IgG antibodies against the measles virus was measured in international units and expressed as IU/mL.

According to the laboratory reference values, an anti-measles IgG concentration of ≥200 mIU/mL (milli-international units per milliliter) was considered indicative of protective immunity.

The development of post-vaccination immunity was assessed 4–6 weeks after vaccination.

4. Statistical Analysis

The collected data were processed using Microsoft Excel and SPSS software.

The results were expressed as:

- Absolute numbers (n);
- Percentages (%);
- 95% confidence intervals (95% CI).

Differences between the study groups were assessed using the chi-square (χ^2) test. A p-value of <0.05 was considered statistically significant.

The study was conducted in accordance with accepted principles of bioethics. Written informed consent was obtained from the parents or legal guardians of all participants.

Results

A total of 36 children were included in the study. Of these, 24 children (66.7%) were under 1 year of age, while 12 children (33.3%) were aged 4–13 years.

According to the serological findings, protective levels of anti-measles IgG antibodies were detected in 22 children in Group I (91.6%; 95% CI: 73.0–98.9%). In 2 children

(8.4%), antibody concentrations were below the protective threshold.

In Group II, stable protective immunity was detected in 11 children (91.7%; 95% CI: 61.5–99.8%). One child (8.3%) demonstrated an insufficient immune response.

No statistically significant difference was observed between the two groups in terms of protective immunity rates ($\chi^2 = 0.0004$; $p > 0.05$). These findings indicate that the effectiveness of vaccination was comparable between the two age groups.

In the total study population, protective immunity was detected in 91.7% of participants (33/36; 95% CI: 77.5–98.2%).

Post-vaccination reactions were observed in 5 children (13.8%; 95% CI: 4.7–29.5%). These reactions were mild and were limited to low-grade fever and local hyperemia. No severe adverse events or serious post-vaccination complications were recorded.

Discussion

The findings of the present study demonstrated that specific measles prevention among children in the Khorezm region has a high level of immunological effectiveness. In the overall study population, the rate of protective immunity was 91.7%. Immune response rates were nearly identical in both age groups, and no statistically significant difference was observed between them ($p > 0.05$).

According to international studies, a live attenuated measles vaccine induces protective immunity in approximately 85–95% of individuals after the first dose, while after revaccination this rate increases to 95–99% [1,2]. In the present study, the rate of protective immunity exceeded 90%, which is consistent with internationally reported data.

According to the World Health Organization, vaccination coverage of at least 95% is required to maintain population-level protection against measles [3]. In the present study, the overall level of protective immunity was 91.7%. Although this indicates a high level of immunological effectiveness, the result also suggests that further improvement in vaccination coverage is necessary to minimize the epidemiological risk of measles transmission.

In a small proportion of children (8.3–8.4%), protective antibody levels were insufficient. In the international literature, such cases are commonly described as “primary vaccine failure.” This phenomenon may be associated with individual characteristics of the immune response, persistence of maternal antibodies, improper vaccine storage conditions, or problems related to vaccine transportation and cold-chain maintenance [4,5].

Seroepidemiological studies conducted in European and Asian countries have also demonstrated that approximately 5–10% of vaccinated children may fail to develop an adequate immune response [6]. The approximately 8% rate observed in our study is therefore consistent with previously published international findings.

Mild post-vaccination reactions were recorded in 13.8% of children, which falls within the 10–20% range reported in international studies [2]. These reactions were mild and transient, and no serious adverse events were observed, supporting the favorable safety profile of the vaccine.

It should be noted that the relatively small sample size ($n = 36$) limits the generalizability of the study findings. Further multicenter studies involving larger pediatric populations are warranted to provide a more comprehensive assessment of post-vaccination immunity against measles.

Overall, the results of this study indicate that specific measles prevention in the Khorezm region is associated with a high level of immunogenicity. The obtained findings are generally consistent with international data and support the effectiveness of the national immunization program. Nevertheless, continued serological monitoring and maintenance of vaccination coverage at 95% or higher are important for ensuring adequate population immunity and reducing the risk of measles transmission.

Conclusion

1. Specific prevention of measles among children in the Khorezm region demonstrated a high level of immunological effectiveness.

2. The rate of protective immunity was 91.6% among children under 1 year of age and 91.7% among children aged 4–13 years.

3. No statistically significant difference in immune response rates was observed between the age groups ($p > 0.05$), indicating comparable vaccination effectiveness in both groups.

4. Post-vaccination reactions were mild and transient, and no serious adverse events were recorded, supporting the safety of measles vaccination.

5. Although the overall level of protective immunity reached 91.7%, maintaining vaccination coverage at 95% or higher and continuing serological monitoring are advisable to ensure adequate population immunity and minimize the risk of measles transmission.

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