Review Article

Measles and vaccination in Mexico: epidemiological resurgence and challenges for elimination in the post-pandemic era

Abstract

Introduction: Measles is a highly contagious viral disease that can be prevented by vaccination. Although Mexico achieved endemic elimination, outbreaks associated with declining vaccination coverage have been reported in recent years.

Objective: To describe the current epidemiological situation of measles in Mexico, the impact of the vaccination program, and clinical control strategies.

Materials and methods: Narrative review based on indexed scientific literature, institutional documents, and international epidemiological reports.

Results: Vaccination coverage has fallen below the 95% threshold required for herd immunity. Between 2025 and 2026, a nationwide outbreak was recorded with thousands of confirmed cases. The primary susceptible population consists of unvaccinated children and young adults.

Conclusions: The reemergence of measles reflects accumulated gaps in immunization. It is essential to strengthen universal vaccination, epidemiological surveillance, and timely management in health services.

Keywords: measles, vaccination, Mexico, immunization

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Introduction

The objective of this review is to analyze the epidemiological resurgence of measles in Mexico and the challenges for its elimination in the post-pandemic era.

Measles is an acute viral exanthematous disease caused by a single-stranded, non-segmented, negative-sense RNA virus of the genus *Morbillivirus*, which is part of the *Paramyxoviridae* family.[1] It is considered one of the most contagious infectious diseases given its estimated basic reproduction number (R0) of between 12 and 18 and a high secondary attack rate, meaning that a single case can generate up to 18 secondary cases, thereby infecting up to 90% of susceptible individuals exposed.[1,2]

Despite this, it is also considered a vaccine-preventable disease, as there is a widely available vaccine that has been proven to be safe and effective for this purpose.[3] The measles vaccine was introduced into the national immunization schedule in 1971, while the last case of endemic transmission in our country was documented in 1995; it was not until 1998 that combined vaccination with the MMR (measles, mumps, and rubella) vaccine was introduced.[4,5] This was done within the framework of the initiative proposed by the World Health Organization (WHO), which aims to prevent outbreaks and maintain elimination in the Region of the Americas, of which Mexico is a part.[4,5] However, the concept of elimination should not be equated with eradication, since transmission can re-establish itself when there are gaps in vaccination coverage.[6]

The COVID-19 pandemic caused significant disruptions to preventive health services worldwide, including routine childhood vaccination. As a result, cohorts of susceptible individuals accumulated, a phenomenon associated with the resurgence of measles on various continents.[7,8] In Mexico, the progressive decline in vaccination coverage, particularly for the first and second doses of the MMR vaccine, has led to the reappearance of outbreaks, posing a major challenge for public health and daily clinical practice.[4,5,7,8]

Epidemiology in Mexico

Before the implementation of widespread vaccination programs, measles was one of the most common infectious diseases affecting children worldwide With outbreaks occurring every 2 to 3 years, according to WHO statistics, in the 1980s, measles was still responsible for 2.6 million deaths annually.[9] Subsequently, in the 1970s in our country, the vaccine was introduced, and the last pandemic affecting the Americas occurred in 1989, peaking at 68,782 cases in 1991.[7] Finally, the endemic circulation of the virus was halted, with no endemic cases reported between 1996 and 2019, and in 2016 the region received certification confirming it was measles-free.[5–7]

Despite this, outbreaks have occurred over time due to declining vaccination coverage and the phenomenon of immune amnesia, which is increasingly recognized as a consequence of natural infection. During the COVID-19 pandemic, other important factors were identified that were specifically associated with the infrastructure and various vulnerabilities of our health system.[4,5] In particular, the temporary interruption of health services , the decline in visits to medical facilities, and the reallocation of resources toward addressing the health emergency became evident, resulting in a decrease in vaccination coverage.[4]

The World Health Organization has noted that a drop in coverage below 95% leads to a loss of herd immunity and facilitates community transmission.[2] Consequently, certain segments of the population are recognized as being more susceptible to this phenomenon:

(i) Unvaccinated pediatric patients or those who have not received their second dose

(ii) Communities with limited access to health services

(iii) Populations 'reluctant' to be vaccinated

(iv) Immigrant populations

(v) Immunocompromised individuals

In addition to declining vaccination coverage, current outbreaks reflect a steady accumulation of susceptible individuals that has occurred over several years, leading to a phenomenon known as "population-level immunological debt." Thus, the resurgence is associated with decreased vaccination coverage and the accumulation of susceptible individuals.[3–5]

In the post-pandemic period, several countries have reported an increase in cases and outbreaks, highlighting the need to strengthen strategies for catching up on vaccination schedules, active epidemiological surveillance, and vaccination campaigns targeting underserved populations to prevent the reemergence of this preventable disease.[4]

Virology and pathophysiology

The measles virus belongs to the *Paramyxoviridae* family within the *Morbillivirus* genus; it is non-enveloped and has a genetic material composed of single-stranded, non-segmented RNA. Its genome encodes six structural proteins; among the non-structural proteins, proteins C and V stand out for inhibiting the host's innate immune response. Transmission occurs via respiratory secretions in large particles that travel short distances, as well as through respiratory aerosols, which allow the virus to remain suspended in the air for up to two hours.

Once these aerosolized secretions are inhaled, the virus initially infects the respiratory epithelium and, with it, the alveolar dendritic cells. It then undergoes a process of primary dissemination, spreading to regional lymph nodes where significant viral replication takes place. Subsequently, with a higher viral load, secondary viremia occurs, allowing systemic dissemination to the skin, conjunctiva, respiratory tract, and reticuloendothelial system.

Recently, the term "immune amnesia" has been introduced to refer to the immunosuppression that natural infection with the measles virus is known to cause. The virus utilizes the CD150/SLAMF1 receptor, which is highly expressed on lymphocytes and antigen-presenting cells. Thus, the measles virus can infect up to 70% of memory cells—including B, T, and plasma cells in lymphoid and peripheral tissues—within the first 10 days of acute infection, leading to the destruction of preexisting immune memory. However, a loss of variability in the immune repertoire was also detected in animal models, on the order of 60%, which persisted for at least 5 months. Therefore, the "reconstruction" of a robust immune system would most likely require re-exposure and could potentially take years. In the meantime, the patient would be susceptible to other infections.

Clinical manifestations

In natural measles virus infection, clinical symptoms typically appear between the 10th and 14th day after exposure (range: 7–23 days). The illness begins with a prodromal phase characterized by fever and the classic triad of cough, runny nose, and conjunctivitis, which usually lasts 2 to 4 days. During this period, Koplik spots may be observed; these are small whitish lesions on a bluish base on the buccal mucosa that, although not always present, are highly suggestive of the disease and considered pathognomonic. They typically appear one or two days before the rash and may persist briefly after its onset. The characteristic rash is erythematous maculopapular and emerges between the second and fourth day of fever, beginning on the face and spreading cephalocaudally toward the trunk and extremities. It usually spares the palms and soles and is highly pruritic. Toward the convalescent period, the erythematous coloration may change and develop slight desquamation. As previously mentioned, transmissibility is high, and the patient is contagious from four days before to four days after the onset of the rash. Diarrhea may also occur in the early stages and can persist for several weeks. Figure 1 schematically illustrates the natural course of the infection.

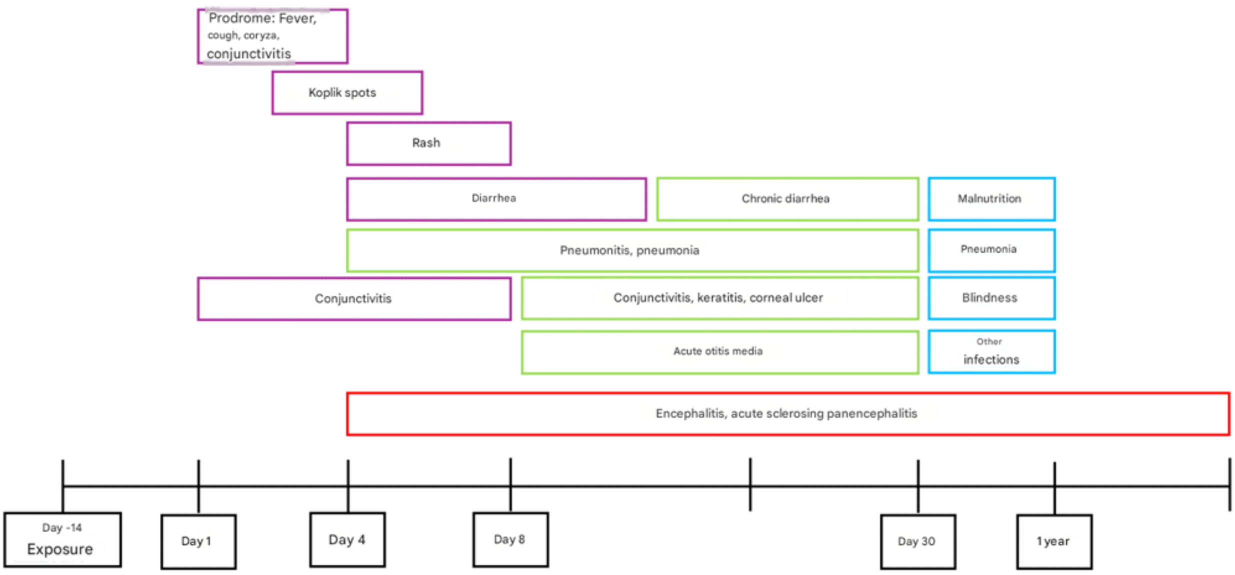

Figure 1 Schematic representation of the clinical course of measles showing the incubation, contagious, and acute disease periods. The main early and late complications associated with virus-induced immunosuppression are illustrated.

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In measles infection, hematogenous spread leads to multisystemic involvement affecting the skin and mucosal epithelia, as well as the respiratory and gastrointestinal tracts. Complications occur in approximately 30% of cases and may manifest both during the acute phase and in the weeks that follow. Among the most common are: pneumonia (widely recognized as the leading cause of mortality), otitis media, conjunctivitis, and persistent diarrhea. Less common, but associated with high morbidity and mortality, are interstitial pneumonitis and giant cell pneumonia, conditions linked to sustained viral replication and typically described in immunocompromised patients and young infants. Following clinical resolution, a state of transient immunosuppression persists, increasing susceptibility to secondary infections and contributing to adverse outcomes such as malnutrition. Likewise, ophthalmological complications represent a significant cause of sequelae, particularly in settings of vitamin A deficiency, where measles keratopathy can progress to severe corneal ulceration and even perforation, with a subsequent risk of irreversible blindness. Table 1 details the most frequent and severe complications.

Table 1 Incidence of severe complications associated with measles. Adapted and translated from Moss WJ. *Measles*. New England Journal of Medicine, 2025, with modifications for academic purposes

Complication	Approximate incidence in developed countries	Clinical comments
Pneumonia	1–6 per 100 cases	Most common complication and leading cause of hospitalization in the first month
Keratitis or keratoconjunctivitis	3–10 per 100 cases	May appear in early stages and persist; risk of eye damage
Diarrhea	8–10 per 100 cases	Common during the acute phase
Otitis media	7–9 per 100 cases	May cause hearing loss
Death	1–3 per 1,000 cases	Higher risk in young children and immunocompromised individuals
Malnutrition	8–10 per 100 cases	Bidirectional relationship with disease severity
Post-infectious encephalitis	~1 per 1,000 cases	Severe acute neurological complication
Measles inclusion encephalitis	~1 per 1,000 cases	More common in immunocompromised individuals
Subacute sclerosing panencephalitis	7–11 per 100,000 cases	Progressive late complication

Vaccination in Mexico

Vaccination is the cornerstone of measles prevention and the sustainability of its elimination. The measles vaccine, commonly used as part of the MMR vaccine (measles, mumps, and rubella), is a live-attenuated virus vaccine with high immunogenicity, low cost, and a strong safety profile. The first dose, generally administered at 12 months of age, induces seroconversion in more than 95% of those vaccinated. The second dose, administered at 18 months of age starting in 2022 in our country, is a strategy designed to immunize those who did not achieve seroconversion after the first dose (primary failure). With this schedule, protective efficacy approaches 93% after one dose and 97% after two doses, with immunity persisting for at least two decades and likely for life in most vaccinated individuals.

Given that the basic reproduction number of the measles virus is estimated to be between 12 and 18, sustained interruption of transmission requires uniform coverage of at least 95% with two doses. This explains why small populations of susceptible individuals can sustain outbreaks even in countries with seemingly acceptable average coverage rates. Recent experience confirms that the loss of elimination is primarily associated with coverage gaps, inaccurate vaccination estimates, insufficient surveillance, and exposure to viral imports from areas with endemic transmission.

The population-level impact of measles vaccination has been considerable. Between 2000 and 2022, it was estimated to have prevented 57 million deaths, and within the Expanded Program on Immunization, it represents one of the interventions that has prevented the most child mortality on a global scale. The COVID-19 pandemic disrupted routine services, supplementary campaigns, and surveillance activities, leading to a decline in global first-dose coverage and leaving millions of children unvaccinated or with incomplete vaccination schedules. Table 2 details the current national measles vaccination schedule in our country.

Table 2 Current national measles vaccination schedule

Age	Vaccine
6 months (during an outbreak)	SRP dose zero
12 months	SRP
18 months/6 years (born before 2022)	SRP
>10 years (during an outbreak)	SR

Diagnosis

The diagnosis of measles infection is based on the correlation between clinical findings, epidemiological context, and laboratory confirmation. From a clinical standpoint, measles should be suspected in cases of fever accompanied by a maculopapular rash and respiratory symptoms such as cough, runny nose, or conjunctivitis, particularly in patients with a history of exposure or who come from areas with active transmission. Koplik spots, when present, are a highly diagnostic finding in the early stages, although their absence does not rule out the disease.

Etiological confirmation is based on serological and molecular methods. The detection of specific IgM antibodies in serum remains a widely used tool; these are typically detectable starting in the first few days after the onset of the rash and persist for several weeks. Complementarily, viral RNA amplification via RT-PCR in respiratory, blood, or urine samples allows for an earlier and more sensitive diagnosis, in addition to facilitating the genotypic characterization of the virus for epidemiological surveillance purposes. The ability to isolate the virus decreases as the immune response progresses and viremia subsides.

Given the virus's high transmissibility and the possibility of transmission prior to clinical recognition of the illness, timely diagnosis has implications not only for clinical management but also for epidemiology. The identification of suspected cases must be accompanied by immediate reporting and control measures, including respiratory isolation and contact tracing, with the aim of interrupting transmission chains. In this context, the integration of clinical criteria with laboratory tools and robust surveillance systems is essential for early detection and outbreak control. In Figure 2, the authors propose a diagnostic algorithm for suspected measles.

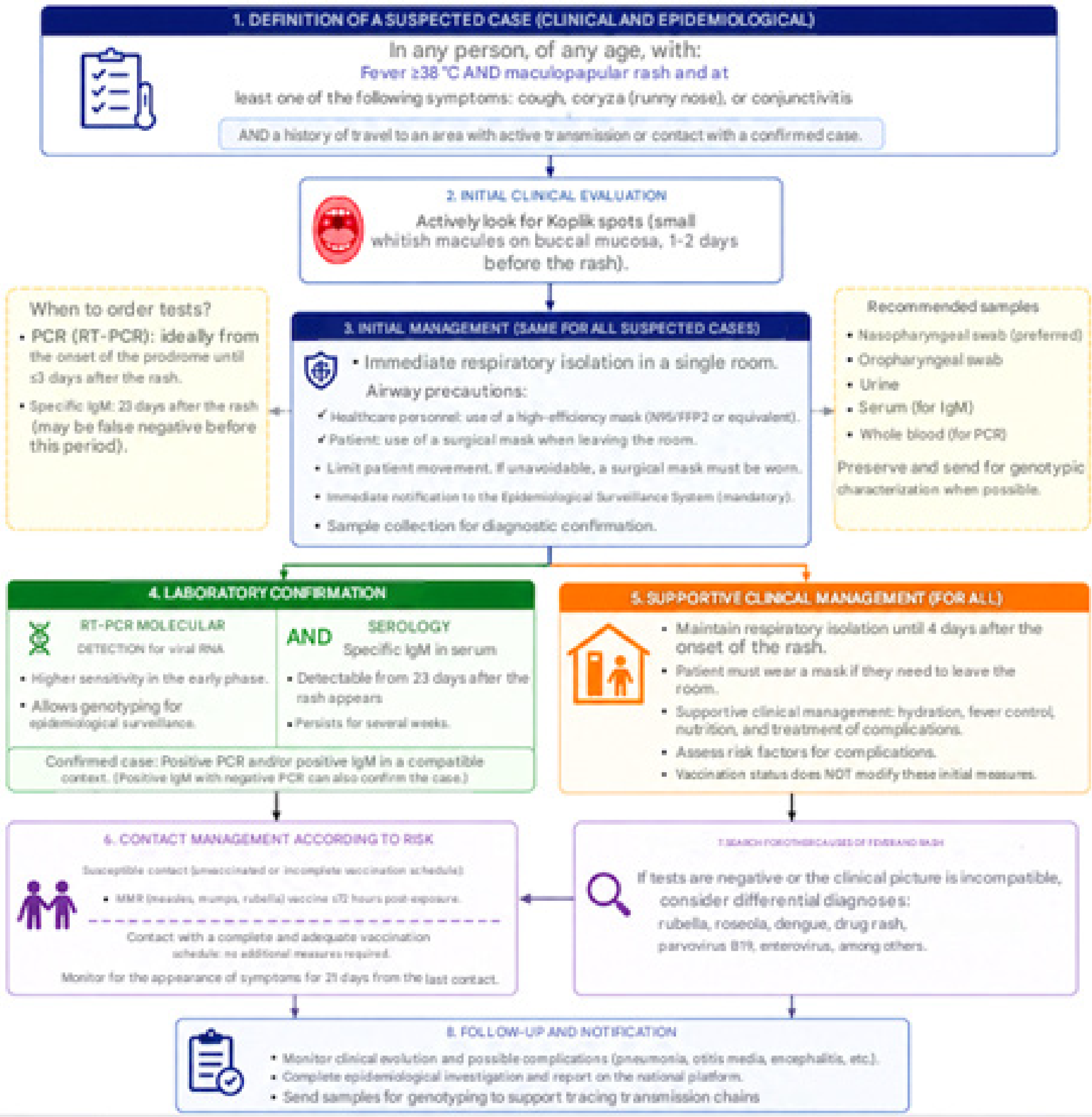

Figure 2 Flowchart summarizing the diagnostic approach for suspected measles, including clinical criteria, isolation measures, laboratory confirmation, and epidemiological reporting.

Treatment

Management of measles infection is essentially supportive and aims to keep the patient stable while an effective immune response is established. This includes adequate hydration, fever control, and close clinical monitoring for the early detection of complications, which most frequently affect the respiratory system and, to a lesser extent, the central nervous system. Pneumonia, whether due to the direct effect of the virus or bacterial superinfection, represents the leading cause of morbidity and mortality and necessitates hospitalization in a significant number of cases.

Furthermore, the administration of vitamin A is a key intervention in the pediatric population. Various studies and international recommendations have shown that its use significantly reduces mortality and the incidence of severe complications, particularly in contexts of malnutrition or severe illness. This effect has been linked to the preservation of epithelial integrity and the modulation of the immune response, which are relevant aspects in an infection characterized by systemic spread and transient immunological alterations. Table 3 details the recommended doses of vitamin A.

Table 3 Recommended doses of vitamin A

Age	Dosage	Frequency
< 6 months	50,000 IU	Daily for 2 days
6–11 months	100,000 IU	Daily for 2 days
>12 months	200,000 IU	Daily for 2 days
History of vitamin A deficiency or eye complications caused by measles	Administer third dose 2 to 4 weeks after the second dose	
Adults	No routine recommendation; individualize	

To date, there is no specific antiviral treatment approved for the routine management of measles. Consequently, the therapeutic approach is complemented by targeted treatment of complications and public health interventions aimed at limiting transmission. The high contagiousness of the virus, along with its ability to spread before clinical recognition, reinforces the importance of early respiratory isolation and active contact tracing as integral components of comprehensive case management.

Discussion

The resurgence of measles following the COVID-19 pandemic reflects the coexistence of multiple factors, including a sustained decline in vaccination coverage, the interruption of immunization programs, and the resumption of international travel. In this context, the reintroduction of the virus into countries previously free of endemic transmission highlights that elimination is not a permanent state, but a dynamic condition that depends on continuous epidemiological surveillance and the maintenance of high levels of population immunity. The progressive accumulation of susceptible individuals, even in settings with high average coverage, can facilitate the emergence of explosive outbreaks from a single index case.

In Mexico, this phenomenon is amplified by regional heterogeneity in vaccination coverage and by limitations in the quality of registration systems. These conditions create pockets of susceptibility that hinder outbreak prevention and underscore the need to integrate clinical surveillance strategies, strengthen vaccination programs, and promote health education. In this scenario, the role of the primary care physician takes on central importance, as early diagnostic suspicion constitutes the starting point for the activation of epidemiological control measures.

From a clinical practice perspective, the reemergence of measles necessitates its reincorporation into the standard differential diagnosis of febrile exanthematous syndromes. The lack of clinical exposure among recent generations of physicians has contributed to diagnostic delays, facilitating transmission in community and hospital settings. Systematic verification of vaccination status should be considered an essential component of clinical evaluation, particularly in the pediatric population and young adults, where recent outbreaks have been documented. The absence of reliable documentation should be assumed to indicate an incomplete vaccination history until proven otherwise.

Likewise, timely recognition of the clinical presentation has direct implications for the prevention of nosocomial outbreaks, given that the virus is transmissible before the rash develops. The immediate implementation of respiratory isolation measures, the use of appropriate protective equipment by healthcare personnel, and epidemiological reporting are critical interventions that depend, to a large extent, on the initial clinical judgment. At the same time, patient management remains primarily supportive, although vitamin A supplementation continues to play a significant role in reducing complications and mortality, particularly in the pediatric population.

Finally, measles control extends beyond the individual and requires interventions targeting the family and community settings, including the identification of susceptible contacts and the implementation of catch-up vaccination strategies. Taken together, these elements demonstrate that measles containment depends both on the strength of health systems and on the clinician's ability to recognize and act promptly in the face of suspected cases.[11–14]

Conclusion

Measles persists as a preventable disease whose reemergence highlights the fragility of the gains made in its control. Sustaining elimination requires not only maintaining high vaccination coverage but also strengthening surveillance systems and promoting timely clinical recognition. In this context, daily medical practice is an essential component in preventing outbreaks and preserving public health gains.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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