South Health and Policy. 2025; 4:285
doi: 10.56294/shp2025285

REVIEW

Measles: A Comprehensive Review of the Virus and Its Public Health Implications

Sarampión: una revisión exhaustiva del virus y sus implicaciones para la Salud Pública

Carlos Alberto Paz-Román[1], Jhossmar Cristians Auza-Santivañez[2], Carlos Daniel Echazu Torres[3], Freddy Ednildon Bautista-Vanegas[4], Daniel Ramiro Elías Vallejos-Rejas[5], Henrry Temis Quisbert-Vasquez[6], Jose Bernardo Antezana-Muñoz[7], Giovanni Callizaya Macedo[8], Mildred Ericka Kubatz La Madrid[9]

[1]Hospital de Niños Mario Ortiz. Clínica de las Américas. Santa Cruz, Bolivia.
[2]Ministerio de Salud y Deportes. Instituto Académico Científico Quispe-Cornejo. La Paz, Bolivia.
[3]Ministerio de Salud y Deportes. Programa Ampliado de inmunización. La Paz, Bolivia.
[4]Kliniken Beelitz GmbH Neurologische Rehabilitationsklinik: Beelitz Heilstätten, Brandenburg, DE. Germany.
[5]Facultad de Medicina. Universidad Privada del Valle Bolivia. Santa Cruz, Bolivia.
[6]Hospital del Niño Manuel Ascencio Villarroel. Cochabamba, Bolivia.
[7]Hospital de Alta Complejidad Presidente Juan Domingo Perón. Unidad de Cuidados Intensivos. Formosa, Argentina.
[8]Hospital del Niño "Dr. Ovidio Aliaga Uría". Departamento de Cirugía Pediátrica. La Paz, Bolivia
[9]Hospital de Tercer Nivel Dr. Hernán Messuti Ribera. Jefe del Servicio de Imagenología. Pando, Bolivia.

Cite as: Paz-Román CA, Auza-Santivañez JC, Echazu Torres CD, Bautista-Vanegas FE, Elías Vallejos-Rejas DR, Quisbert-Vasquez HT, et al. Measles: A Comprehensive Review of the Virus and Its Public Health Implications. South Health and Policy. 2025; 4:285. https://doi.org/10.56294/shp2025285

Submitted: 22-02-2025 **Revised:** 15-05-2025 **Accepted:** 09-08-2025 **Published:** 10-08-2025

Editor: Dr. Telmo Raúl Aveiro-Róbalo

Corresponding Author: Carlos Alberto Paz-Román

ABSTRACT

Historically, measles has been an infectious disease responsible for significant morbidity and mortality worldwide. Global vaccination efforts have had a transformative impact, with measles immunization estimated to have prevented more than 60 million deaths globally between 2000 and 2023. Despite these successes, the global goal of measles elimination by 2030, outlined in the Measles and Rubella Strategic Framework 2021-2030, is now under considerable threat due to the recent re-emergence of the disease. Addressing the measles crisis is not only about containing this specific virus, but also about strengthening the fundamental resilience of public health systems worldwide to prepare for and mitigate a broader spectrum of infectious disease threats. This narrative review article aims to provide a comprehensive analysis of the global re-emergence of measles. Clinical and epidemiological trends will be detailed, key factors contributing to this resurgence will be identified, and public health implications will be examined. An analysis of the situation in Bolivia will be included, offering localized perspectives on the challenges and responses. Finally, the article will conclude with strategic recommendations for public health interventions and future preparedness.

Keywords: Measles; Morbillivirus; Vaccination; Reemergence; Infectious Disease.

RESUMEN

Históricamente, el sarampión ha sido una enfermedad infecciosa responsable de una morbilidad y mortalidad significativas en todo el mundo. Los esfuerzos globales de vacunación han tenido un impacto transformador, estimándose que la inmunización contra el sarampión evitó más de 60 millones de muertes a nivel mundial entre 2000 y 2023. A pesar de estos éxitos, el objetivo global de eliminación del sarampión para 2030, delineado en el Marco Estratégico de Sarampión y Rubéola 2021-2030, se encuentra ahora bajo una amenaza considerable debido a la reciente reemergencia de la enfermedad. Abordar la crisis del sarampión no se trata solo de contener este virus específico, sino de fortalecer la resiliencia fundamental de los sistemas de salud pública en todo el mundo para prepararse y mitigar un espectro más amplio de amenazas de enfermedades infecciosas. El presente artículo de revisión narrativa, tiene como objetivo proporcionar un análisis exhaustivo de la reemergencia global del sarampión. Se detallarán las tendencias clínicas y epidemiológicas, se identificarán los factores clave que contribuyen a este resurgimiento y se examinarán las implicaciones para la salud pública. Se incluirá un análisis sobre la situación en Bolivia, ofreciendo perspectivas localizadas sobre los desafíos y las respuestas. Finalmente, el artículo concluirá con recomendaciones estratégicas para intervenciones de salud pública y preparación futura.

Palabras clave: Sarampión; Morbillivirus; Vacunación; Reemergencia; Enfermedad Infecciosa.

INTRODUCTION

Historically, measles has been a devastating infectious disease, responsible for significant morbidity and mortality worldwide. However, the development of effective vaccines, such as the measles, mumps, and rubella (MMR) vaccine in the 1960s, offered unprecedented promise for control and eventual elimination.[1] Global vaccination efforts have had a transformative impact, with measles immunization estimated to have prevented more than 60 million deaths worldwide between 2000 and 2023.[4,5] These achievements led to important milestones, such as the declaration of measles elimination in the United States in 2000 and elimination status in the Americas Region in 2016, revalidated in 2024.[1,6]

Despite these successes, the global goal of measles elimination by 2030, outlined in the Measles and Rubella Strategic Framework 2021-2030, is now under considerable threat due to the recent reemergence of the disease.[7,8] The current situation highlights that “elimination” status is not a permanent state of eradication, but a delicate balance that requires constant vigilance and uninterrupted public health efforts.[1] The dramatic resurgence of cases in 2025, even in regions that had achieved elimination, demonstrates that this status can be rapidly eroded if underlying immunity gaps are allowed to persist or reappear.[9] The reemergence of measles in 2025 represents a public health crisis of major magnitude.[1] Measles is one of the most infectious viruses known to humans, with a basic reproduction number (R0) ranging from 12 to 18, meaning that approximately 90 % of susceptible individuals will become infected after exposure.[10,11,12] This high transmissibility makes it a significant threat, capable of spreading rapidly through populations with insufficient immunity.

The World Health Organization (WHO) had already warned in February 2024 that more than half of the world’s countries could anticipate significant measles outbreaks in 2024, following a resurgence in Europe.[1] This projection has materialized in the current crisis of 2025. Measles is often described as the “canary in the coal mine” for global health systems.[8] This analogy is profound, as it elevates the reemergence of measles from a single disease problem to a critical indicator of systemic fragility within global public health. If a highly contagious, well-understood, and vaccine-preventable disease such as measles is resurging, it signals deeper problems such as erosion of trust in vaccines, weakening routine immunization programs, and inadequate surveillance.

Addressing the measles crisis is not just about containing this specific virus, but about strengthening the fundamental resilience of public health systems worldwide to prepare for and mitigate a broader spectrum of infectious disease threats.

This narrative review article aims to provide a comprehensive analysis of the global resurgence of measles. Epidemiological trends will be detailed, key factors contributing to this resurgence will be identified, and implications for public health will be examined. A specific case study on the situation in Bolivia in 2025 will be included, offering localized perspectives on challenges and responses. Finally, the article will conclude with strategic recommendations for public health interventions and future preparedness.

METHOD

A search for information was conducted between May and July 2025 in the SciELO, Scopus, PubMed/MedLine databases, the Google Scholar search engine, and the Clinical Keys services. Advanced search strategies were used to retrieve the information, structuring search formulas using the terms “Sarampión,” “Morbillivirus,” “Paramyxoviridae,” as well as their English translations “Measles,” “Morbillivirus,” “Paramyxoviridae.” Boolean operators were used to combine the terms, with search formulas according to the syntax requested by each database. From the resulting documents, those written in the last 10 years, in Spanish or English, that provided updated information on measles were selected. In addition, in order to achieve a review based on the best possible evidence, only case series studies, original articles, systematic reviews, or epidemiological reports were selected.

RESULTS

Characteristics of the virus

Measles is a highly infectious disease of viral etiology caused by a single-stranded, non-segmented, enveloped RNA virus[13,14] of the genus Morbillivirus, belonging to the Paramyxoviridae family.[2] Humans are the only known natural hosts for the wild measles virus.[15,16] There are 24 different genotypes of the wild measles virus, grouped into eight lineages, from "A" to "H," which allows the circulation of the virus to be tracked worldwide. The virus encodes six structural proteins, including hemagglutinin (H) and fusion protein (F), which are crucial for the virus to bind to and spread within host cells.[14,18]

Clinical manifestations

It manifests with a prodromal phase that usually lasts 2 to 4 days, presenting an acute febrile syndrome that reaches 40°C (104°F),[19,20,21] general malaise, anorexia, and the triad known as "the triple C," which consists of cough, coryza (nasal discharge or rhinorrhea), and conjunctivitis.[13,20] Koplik's spots are also evident as an early pathognomonic sign, although they are not always present: small whitish or bluish-white lesions on an erythematous base on the oral mucosa; although they are considered characteristic, they may or may not appear within the first two to three days before the rash and last for two to three days.[19,21] Subsequently, a characteristic maculopapular rash develops, appearing approximately 14 days after exposure to the virus and spreading in a cephalocaudal direction, which at first blanches on pressure but in more severe cases may be hemorrhagic (Figure 1A-1B).[17,22] The rash appears as spots (macules) with small elevations on the skin (papules), without pus, and usually appears around the neck and face, particularly around the hairline and behind the ears,[21,23] then spreading to the hands and feet in approximately three days, remaining for five to six days before fading.[4,14] The virus infects the respiratory tract before spreading throughout the body.[2]

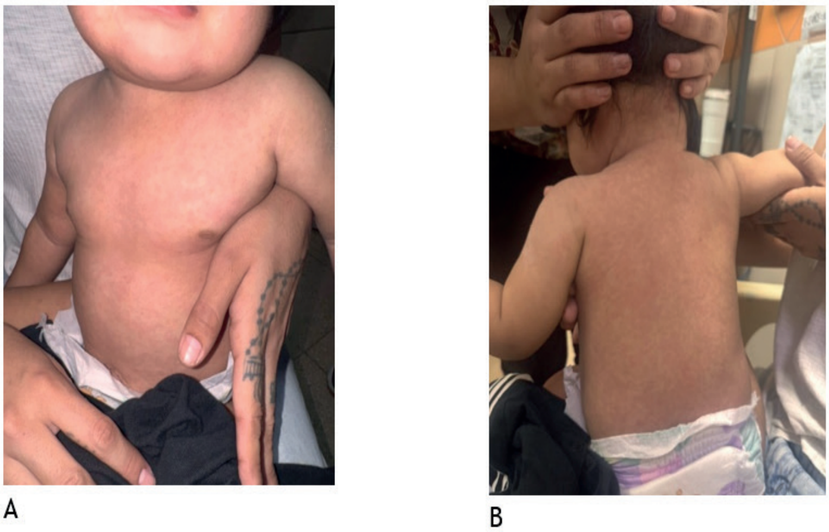


Figure 1. A: Diffuse erythematous maculopapular rash on the abdomen and chest of a pediatric patient. **B:** Similar erythematous maculopapular rash spread across the back and arms of the same pediatric patient

Table 1. History of the disease and clinical manifestations

Disease history	Details	Progression/Time	Key Notes
Incubation period	Asymptomatic or with subtle manifestations.[13,24]	7 to 21 days (average 10- 14 days).[13,25]	The virus initially replicates in the respiratory epithelium and mononuclear phagocytic system.[13,24]
Prodromal phase	General malaise Anorexia Fever (may be high, up to 39-40°C) Cough Runny nose (rhinorrhea) Conjunctivitis (red, watery eyes) Koplik spots: Whitish/blue-white lesions with an erythematous halo on the oral mucosa, usually in front of the first molar.[19,25]	Typically 2 to 4 days. Koplik spots appear 1-2 days before the rash and last 12-72 hours.[13,20]	They intensify before the rash. Koplik spots are pathognomonic, but not always present (only in 60-70 % of cases, or not in all patients), and fleeting.[20,24]

Exanthematic phase	Maculopapular rash (spots and papules), erythematous, initially blanching on pressure. May include petechiae, or be hemorrhagic in severe cases. No pus or vesicles present. The extent of the rash and the degree of confluence correlate with severity in children.[24,26]	Appears 3-4 days after the onset of fever, or 1-2 days after Koplik spots. Generally appears ~14 days after exposure. Starts on the face, particularly around the hairline and behind the ears, and on the upper neck. It spreads cephalocaudally (from the head to the feet) and centrifugally. It affects the trunk and then the extremities. It lasts 3 to 7 days, or 3-4 days before fading. It disappears in the same order in which it appeared.[20,24]	The palms and soles are rarely affected. Cephalocaudal progression is characteristic but not pathognomonic. Patients are infectious from four days before to four days after the onset of the rash.[24,25]
Recovery phase	Persistent cough. Skin peeling (especially in malnourished children). The immune system creates memory mechanisms and permanent immunity. Transient immunosuppression, which can last up to 3 years, increasing susceptibility to secondary infections.[15,24]	After resolution of the rash.[13]	Immunosuppression is important.[15,24]
Modified measles (in vaccinated individuals)	Longer incubation period. Less intense prodromal and exanthematous phases.[25]	Incubation period of 14 to 21 days.[25]	Observed in previously vaccinated patients.[25]

Mechanism of infection

Measles virus (MV) is a disease that is transmitted mainly through the respiratory tract[18,27] via large respiratory droplets or small particle aerosols that remain suspended in the air for up to 2 hours.[23,27] As the infection begins in the respiratory tract, it is believed that MV enters the host by initially infecting alveolar macrophages and/or dendritic cells in the airways, where epithelial cells would not be the target cells at the onset of infection.[18,27] In proposals, research suggests that the virus uses a similar infection strategy to that of HIV (Human Immunodeficiency Virus), where MHC (Major Histocompatibility Complex) class II+ CD11c+ dendritic cells capture the virus from the airway lumen and migrate to regional lymph nodes, thereby transmitting MV to lymphocytes and initiating infection.[16,18] After initial replication in the lungs and lymphoid organs, the virus spreads throughout the body via viremia, mainly mediated by infected CD150+ lymphocytes (T and B cells), which are the main sites of viral replication and dissemination.[18,27] The infection then spreads to almost all organ systems, including epithelial and endothelial cells, through direct cell-to-cell transmission.[17,24]

Epidemiology

Before the introduction of the vaccine in the 1960s, measles caused more than 2 million deaths annually. Although vaccination strategies have dramatically reduced this burden, preventing an estimated 60 million deaths between 2000 and 2023, the disease persists in areas with low vaccination coverage and outbreaks resurface due to declining vaccineacceptance,[28] the disease persists in areas with low vaccination coverage, and outbreaks resurface due to declining vaccination acceptance.[29,30] In 2023, 663795 cases were reported, and an estimated 10,3 million people were infected, with 107500 deaths, representing a 20 % increase since 2022.[4,28,31] At the same time, the global immunization rate (first dose of measles vaccine, MCV1) declined from 86 % in 2019 to 81 % in 2021.[1,22] Recovering to 83 % in 2023.[28,31,32]

This situation left approximately 22 million infants without receiving at least one dose of the vaccine.[33] Risk groups include children under the recommended vaccination age, unvaccinated individuals, individuals who have not received a second dose, and those with vaccine failure,[3,6] with the risk increasing with travel to endemic regions. The most common complications occur in children under five and adults over 30 with malnutrition or weakened immune systems.[4] Measles is one of the most contagious diseases, transmitted by respiratory secretions when coughing or sneezing, with the virus remaining active in the air for up to two hours. It is so highly transmissible that it can infect nine out of ten unvaccinated contacts and is contagious from four days before to four days after the onset of the rash.[22,23]

Vaccination and surveillance

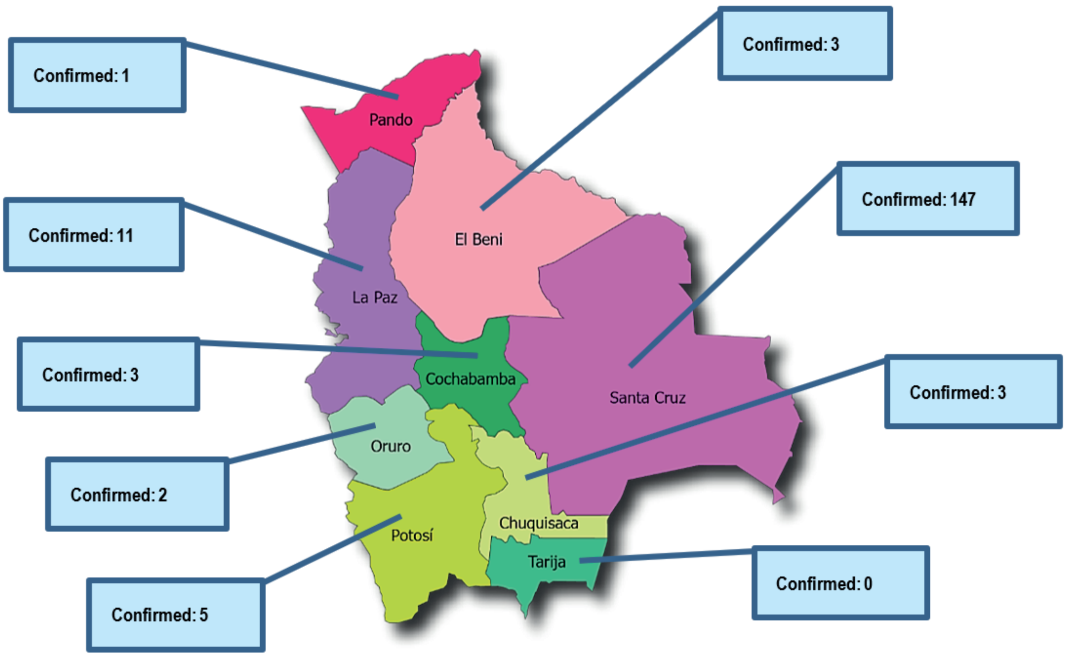
Natural infection with measles confers lifelong immunity, while immunization with two doses provides protection greater than 95 %[2], with the probability of infection in unvaccinated individuals hundreds of times higher during outbreaks. Infants born to vaccinated mothers have lower maternal antibody transfer than those whose mothers acquired natural immunity, reducing passive immunity and increasing susceptibility in children under 12 months,[2,31] a situation that is exacerbated by maternal HIV coinfection. The Pan American Health Organization/World Health Organization (PAHO/WHO) recommends: Implementing vaccination intensification activities based on the results of the measles risk analysis, with the aim of closing coverage gaps, prioritizing municipalities at highest risk. Conduct microplanning of routine vaccination services to achieve vaccination coverage of at least 95 % with two doses of the vaccine. Increase efforts to achieve vaccination coverage in reluctant populations, including awareness-raising activities targeting local authorities, community and religious leaders, as well as other key social actors and government sectors, such as the education sector. Strengthen epidemiological surveillance in areas considered high risk, border areas, and areas with epidemiological silence through the implementation of active case finding in both health services and the community.

Epidemiological situation in the Americas

The global reemergence of measles in 2025 has shown different regional patterns, with the Region of the Americas being the most affected.[35,36] A total of 8,839 confirmed cases were reported in the Region of the Americas through epidemiological week 28 of 2025.[37] This represents an alarming 29-fold increase compared to the 244 cases reported in the same period in 2024, with 7,132 confirmed cases and 13 deaths reported through mid-June in the region.[34,37] The regional trend showed a steady increase in cases since epidemiological week 1, reaching a significant peak between weeks 14.[34,37] Canada (3170 confirmed cases, 1 death), Mexico (2597 confirmed cases, 9 deaths), and the United States (1227 confirmed cases, 3 deaths) accounted for the highest disease burden through epidemiological week 28 of 2025. Other countries with confirmed cases in the region as of the same week included Argentina (35 cases), Belize (34 cases), Brazil (5 cases), Peru (4 cases), and Costa Rica (1 case).[34,37]

Epidemiological situation in Bolivia

The Andean country had maintained "elimination" of measles since 2000, but in line with the regional trend, no cases were reported in 2022 and 2023. In 2024, three positive cases of measles were reported and were successfully controlled. On January 31, 2024, an epidemiological alert for measles was issued, and on June 23, 2025, a National Health Emergency Declaration was issued. As of July 22, 2025, 149 positive cases of measles have been confirmed nationwide (figure 2). The age distribution of the outbreak was wide, ranging from 9 months to 44 years, mainly affecting children aged 5 to 9 years (30,0 %) and people aged 10 to 19 years (28,3 %).[34,38]



Source: Ministry of Health and Sports. General Directorate of Epidemiology
Figure 2. Measles: Confirmed cases (July 27, 2025)

Diagnosis of the disease

Measles is diagnosed in patients who present with fever and a generalized maculopapular rash, especially if accompanied by cough, coryza (nasal discharge), or conjunctivitis (red eyes).[20] Koplik spots, small whitish papules on the oral mucosa, are a pathognomonic sign that may appear one or two days before the rash, although they are not always observed.[20,39] Due to the recent low incidence, many physicians are unfamiliar with the disease, which may hinder initial clinical diagnosis.[22,39] Therefore, immediate laboratory investigation is recommended upon suspicion for rapid confirmation and implementation of control measures.[22,40] Essential laboratory tests include detection of specific IgM antibodies against measles in serum by ELISA and detection of measles viral RNA by polymerase chain reaction (RT-PCR) in nasopharyngeal/throat swab or urine samples.[3,40] It is important to note that samples taken within 0 to 3 days after the onset of the rash may yield false-negative IgM test results.[40] In addition, molecular analysis (genotyping) is crucial for characterizing the circulating virus and tracing transmission chains.[3,22] In low-prevalence settings, interpretation of IgM results can be complex due to possible false positives, and caution is required. All suspected cases should be reported immediately to public health authorities, who provide guidance on sample collection and infection control interventions, including isolation of the patient for at least four days after the onset of the rash to prevent spread.[3,20,23]

Differential diagnosis

The differential diagnosis of measles is crucial and often challenging, especially in settings where the disease is rare and clinicians may not be familiar with its full presentation.[1] Confusion arises because measles shares key features such as fever and maculopapular rash with numerous conditions, both infectious and noninfectious.[2,39] Viral diseases that should be considered include rubella, roseola (human herpesvirus 6), Kawasaki disease, parvovirus B19 infections (infectious erythema), dengue, Zika, chikungunya, infectious mononucleosis, and other common respiratory virus infections such as rhinovirus, parainfluenza, influenza, and adenovirus.[41] Although classic measles is associated with cough, coryza, and conjunctivitis, and Koplik spots (small whitish papules on the oral mucosa) are pathognomonic but not always present, the distinctive progression of the rash and respiratory symptoms help to differentiate it.[37] Bacterial infections such as scarlet fever (caused by Group A Streptococcus), which presents with an erythematous rash and pharyngitis, or meningococcemia, which can manifest with a petechial rash, should also be distinguished. Other conditions to consider are Rocky Mountain fever, respiratory infections caused by Mycoplasma pneumoniae with a maculopapular or vesicular rash, and multisystem inflammatory syndrome in children (MIS-C) related to SARS-CoV-2.[2] In addition, drug-induced skin rashes and Fordyce spots (benign sebaceous glands on the oral mucosa) can mimic measles and Koplik spots, respectively.[39] Given this complexity, laboratory confirmation is essential and includes the detection of specific IgM antibodies against measles in serum (although IgM tests can give false positives, for example with parvovirus B19)[3] and detection of measles viral RNA by RT-PCR in nasopharyngeal, throat, or urine swab samples. It is also crucial to differentiate measles from vaccine reactions or vaccine-induced measles, an attenuated and non-contagious form that can occur in vaccinated individuals and is distinguished by special PCR techniques.[16]

Treatment

Treatment for measles focuses primarily on supportive measures, as there is currently no specific antiviral therapy for the virus.[20,25] These measures include managing fever with antipyretics, adequate hydration and appropriate nutritional support, monitoring the patient's daily weight, and encouraging breastfeeding in infants, as well as small, frequent meals in children.[22] Vitamin A administration is a key intervention, recommended immediately upon diagnosis by the World Health Organization (WHO), the American Academy of Pediatrics, and the Centers for Disease Control and Prevention (CDC), especially in children, as it has been shown to reduce morbidity and mortality and prevent eye damage and blindness.[3,23,30] Doses are 50000 IU for infants under 6 months, 100000 IU for infants 6 to 11 months, and 200000 IU for children 12 months and older, administered orally once a day for two consecutive days, with a third dose 4-6 weeks later if there are signs of vitamin A deficiency.[15,23] For adults, it may be beneficial, especially in populations with vitamin A deficiency, to use lower and more frequent doses in women of reproductive age due to possible teratogenic effects.[23] Ribavirin is an experimental agent that some experts suggest for measles pneumonia in infants younger than 12 months, patients 12 months or older who require ventilatory support, and immunosuppressed patients, although it is not approved by the FDA for this indication.[25,30] Antibiotics are not routinely indicated, but only when there is clinical evidence of bacterial complications, such as pneumonia or acute otitis media.[13,23,24]

Infection control

Infection control for measles is crucial due to its high contagiousness and airborne transmission.[19,22] A room occupied by a suspected case should not be used for two hours after departure. Immediate isolation of suspected or confirmed cases is required, ideally in a negative pressure room. Healthcare personnel should wear respiratory protection, such as an N95 respirator, and the patient should wear a surgical mask. The isolation period for healthy patients is at least four days after the onset of the rash, and for immunocompromised patients, throughout the duration of the disease.[24] Early detection and immediate notification to public health

https://doi.org/10.56294/shp2025285 ISSN: 3072-7677

authorities are mandatory to initiate control actions, contact tracing, and outbreak containment.[22,23] It is essential that healthcare personnel have evidence of immunity. PAHO/WHO also recommends strengthening active epidemiological surveillance and training of rapid response teams for outbreaks.[24]

CONCLUSION

Measles remains one of the most challenging viral diseases for public health, not only because of its high transmissibility, but also because of its profound clinical, epidemiological, and social implications. This review has provided a comprehensive understanding of the many facets of the disease, from the characteristics of the virus and its mechanism of infection to the complex epidemiological dynamics that determine its reemergence. Recent figures reported in the Region of the Americas and in countries such as Bolivia show that confidence in immunization, sustained vaccination coverage, and active epidemiological surveillance remain important tasks. It is essential to strengthen diagnostic capacities, both clinical and laboratory. Vaccination, improving health education, integrating infection control strategies, and ensuring timely responses should not be an option, but a technical priority. Treatment continues to be mainly supportive, which underscores, once again, that the real tool for control is prevention.

BIBLIOGRAPHICAL REFERENCES

1. Parums DV. A review of the resurgence of measles, a vaccine-preventable disease, as current concerns contrast with past hopes for measles elimination. Med Sci Monit. 2024;30:e944436. Available at: http://dx.doi.org/10.12659/MSM.944436

2. Kondamudi NP, Tobin EH, Waymack JR. Measles. En: StatPearls. Treasure Island (FL): StatPearls Publishing; 2025 Available at: https://www.ncbi.nlm.nih.gov/books/NBK448068/

3. Centers for Disease Control and Prevention (CDC). Clinical overview of measles. Measles (Rubeola). 2025. Available at: https://www.cdc.gov/measles/hcp/clinical-overview/?CDC_AAref_Val=https://www.cdc.gov/measles/hcp/index.html

4. World Health Organization (WHO). Measles. Who.int. 2024. Available at: https://www.who.int/news-room/fact-sheets/detail/measles

5. Pan American Health Organization (PAHO). Recent outbreaks in the Americas underscore need to urgently address immunization gaps, PAHO Director says. Paho.org. 2024. Available at: https://www.paho.org/en/news/24-4-2025-recent-outbreaks-americas-underscore-need-urgently-address-immunization-gaps-paho

6. World Health Organization (WHO). Measles - United States of America. Who.int. 2025. Available at: https://www.who.int/emergencies/disease-outbreak-news/item/2025-DON561

7. Beaudoin M, Gosselin P. An effective public health program to reduce urban heat islands in Québec, Canada. Rev Panam Salud Publica-pan Am J Public Health. 2016;40(3):160–6. Available at: https://iris.paho.org/handle/10665.2/31230

8. World Health Organization (WHO). Measles and rubella strategic framework 2021-2030. Ginebra, Suiza: World Health Organization; 2021.

9. Jha AK, Psaki S. Measles: restoring confidence in vaccine information. BMJ. 2025;390:r1389. Available at: http://dx.doi.org/10.1136/bmj.r1389

10. World Economic Forum. Measles cases are still rising – are we at a tipping point?. Weforum.org. 2025. Available at: https://www.weforum.org/stories/2025/05/measles-cases-rising-health-vaccines/

11. Sidharthan C. Why measles is making a comeback despite available vaccines. News-Medical. 2025. Available at: https://www.news-medical.net/health/Measles-makes-a-comeback-How-vaccine-hesitancy-Is-fueling-a-21st-century-crisis.aspx

12. Memorial Sloan Kettering Cancer Center Library. MSK library guides: Measles: Global measles outbreaks. Mskcc.org. 2025. Available at: https://libguides.mskcc.org/measles/global

13. Alves Graber EM, Andrade FJ Jr, Bost W, Gibbs MA. An update and review of measles for emergency

physicians. J Emerg Med. 2020;58(4):610–5. Available at: http://dx.doi.org/10.1016/j.jemermed.2020.02.007

14. Berche P. History of measles. Presse Med. 2022;51(3):104149. Available at: http://dx.doi.org/10.1016/j.lpm.2022.104149

15. Delpiano L, Astroza L, Toro J. Measles: the disease, epidemiology, history and vaccination programs in Chile. Rev Chilena Infectol. 2015;32(4):417–29. Available at: http://dx.doi.org/10.4067/S0716-10182015000500008

16. Misin A, Antonello RM, Di Bella S, Campisciano G, Zanotta N, Giacobbe DR, et al. Measles: An overview of a re-emerging disease in children and immunocompromised patients. Microorganisms. 2020;8(2):276. Available at: http://dx.doi.org/10.3390/microorganisms8020276

17. Gastañaduy PA, Goodson JL, Panagiotakopoulos L, Rota PA, Orenstein WA, Patel M. Measles in the 21st century: Progress toward achieving and sustaining elimination. J Infect Dis. 2021;224(12 Suppl 2):S420–8. Available at: http://dx.doi.org/10.1093/infdis/jiaa793

18. Moss WJ. Measles. Lancet. 2017;390(10111):2490–502. Available at: http://dx.doi.org/10.1016/S0140-6736(17)31463-0

19. Do LAH, Mulholland K. Measles 2025. N Engl J Med. 2025;(NEJMra2504516). Available at: http://dx.doi.org/10.1056/NEJMra2504516

20. Gans H, Maldonado YA. Measles: Clinical manifestations, diagnosis, treatment, and prevention. UpToDate. 2025. Available at: https://www.uptodate.com/contents/measles-clinical-manifestations-diagnosis-treatment-and-prevention?search=SARAMPION&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1

21. Stinchfield PA. Measles: A clinician's guide to a reemerging disease. Nursing. 2020;50(1):39–43. Available at: http://dx.doi.org/10.1097/01.NURSE.0000615088.55221.bb

22. Matysiak-Klose D, Mankertz A, Holzmann H. The epidemiology and diagnosis of measles—special aspects relating to low incidence. Dtsch Arztebl Int. 2024;121(26):875–81. Available at: http://dx.doi.org/10.3238/arztebl.m2024.0211

23. World Health Organization (WHO). Guide for clinical case management and infection prevention and control during a measles outbreak. Ginebra, Suiza: World Health Organization; 2020. Available at: https://iris.who.int/handle/10665/331599

24. Vargas-Soler JA, Morales-Camacho WJ, Plata-Ortiz S, Macías-Celis AC, Nocua-Alarcón LX, Noguera-Sánchez AM, et al. Sarampión en pediatría: el resurgir de una enfermedad prevenible por vacunación. Rev Mex Pediatr. 2020;87(1):30–7. Available at: http://dx.doi.org/10.35366/93266

25. Eugènia Agut-Busquet, Agut-Busquet E, Eugenia Agut-Busquet, Emili Gené Tous, Tous EG, Gemma Navarro, et al. Reemergencia del sarampión en pacientes vacunados: descripción de seis casos y propuesta para su prevención. Emergencias. 13 de mayo de 2016;28(3):182-4.

26. Ministerio de Salud y Deportes de Bolivia. Bolivia reporta segundo caso de sarampión del año 2025. Salud refuerza la vigilancia epidemiológica y bloqueo vacunal. 2025. Disponible en: https://www.minsalud.gob.bo/8658-bolivia-reporta-segundo-caso-de-sarampion-del-ano-2025-salud-refuerza-la-vigilancia-epidemiologica-y-bloqueo-vacunal

27. De Vries RD, Mesman AW, Geijtenbeek TBH, Duprex WP, de Swart RL. The pathogenesis of measles. Curr Opin Virol. 2012;2(3):248–55. Available at: http://dx.doi.org/10.1016/j.coviro.2012.03.005

28. Pan American Health Organization (PAHO). Measles. Paho.org. Available AT: https://www.paho.org/en/topics/measles

29. Sallam, Al-Baidhani, Sallam. Addressing vaccine hesitancy in the age of measles resurgence: A mini-review. Vaccines & Vaccination Open Access. 2025;10(1):1–13. Available at: http://dx.doi.org/10.23880/vvoa-

16000178

30. Parums DV. A review of the resurgence of measles, a vaccine-preventable disease, as current concerns contrast with past hopes for measles elimination. Med Sci Monit. 2024;30:e944436. Available at: http://dx.doi.org/10.12659/MSM.944436

31. Organización Mundial de la Salud (OMS). Sarampión. Who.int. Disponible en: https://www.who.int/es/news-room/fact-sheets/detail/measles

32. Minta AA, Ferrari M, Antoni S, Lambert B, Sayi TS, Hsu CH, et al. Progress toward measles elimination - worldwide, 2000-2023. MMWR Morb Mortal Wkly Rep. 2024;73(45):1036–42. Available at: http://dx.doi.org/10.15585/mmwr.mm7345a4

33. Pan American Health Organization (PAHO). Public Health Risk Assessment related to measles: implications for the Americas Region - 24 March 2025. Paho.org. Available at: https://www.paho.org/en/documents/public-health-risk-assessment-related-measles-implications-americas-region-24-march-2025

34. Pan American Health Organization (PAHO). Epidemiological update measles in the Americas Region - 2 may 2025. Paho.org. 2025. Available at: https://www.paho.org/en/documents/epidemiological-update-measles-americas-region-2-may-2025

35. Centers for Disease Control and Prevention (CDC). Global measles outbreaks. Global Measles Vaccination. 2025. Available at: https://www.cdc.gov/global-measles-vaccination/data-research/global-measles-outbreaks/index.html

36. Pan American Health Organization (PAHO). Measles cases rise in the Americas in 2025. Paho.org. 2025. Available at: https://www.paho.org/en/news/3-7-2025-measles-cases-rise-americas-2025

37. Pan American Health Organization (PAHO). Measles rubella bi-weekly bulletin (27-28) - 12 July 2025. Paho.org. 2025. Available at: https://www.paho.org/en/documents/measles-rubella-bi-weekly-bulletin-27-28-12-july-2025

38. Ministerio de Salud y Deportes. Prensa. La vacunación es la primera medida de seguridad para el retorno a clases: salud y educación alistan protocolo específico contra el sarampión.2025. Disponible en: https://www.minsalud.gob.bo/8769-la-vacunacion-es-la-primera-medida-de-seguridad-para-el-retorno-a-clases-salud-y-educacion-alistan-protocolo-especifico-contra-el-sarampion

39. Vargas-Soler JA, Morales-Camacho WJ, Plata-Ortiz S, Macías-Celis AC, Nocua-Alarcón LX, Noguera-Sánchez AM, et al. Sarampión en pediatría: el resurgir de una enfermedad prevenible por vacunación. Rev Mex Pediatr. 2020;87(1):30–7. Disponible en: http://dx.doi.org/10.35366/93266

40. Sowers SB, Anthony K, Mercader S, Colley H, Crooke SN, Rota PA, et al. Performance characteristics of six immunoglobulin M enzyme-linked immunosorbent assays used for laboratory confirmation of measles. J Clin Microbiol. 2022;60(12):e0122722. Available at: http://dx.doi.org/10.1128/jcm.01227-22

41. Gómez-Santana M, Huerta-Manzano MA, Hernández-Rodríguez P, Vega-Mendoza S, Camarillo-Nava VM. Análisis epidemiológico del brote de sarampión 2020 en la zona norte de la Ciudad de México. Rev Mex Med Fam. 2022;9(4). Disponible en: http://dx.doi.org/10.24875/rmf.22000034

42. Chen SSP. Measles treatment & management. Medscape.com. Medscape; 2025. Available at: https://emedicine.medscape.com/article/966220-treatment

FUNDING

The authors did not receive funding for the implementation of this study.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTION

Conceptualization: Jhossmar Cristians Auza-Santivañez, Carlos Alberto Paz-Román
Data curation: Carlos Alberto Paz-Román, Mildred Ericka Kubatz La Madrid
Formal analysis: Freddy Ednildon Bautista-Vanegas
Research: Jhossmar Cristians Auza-Santivañez, Jose Bernardo Antezana-Muñoz
Methodology: Jhossmar Cristians Auza-Santivañez, Giovanni Callizaya Macedo.
Project management: Carlos Alberto Paz-Román
Resources: Jose Bernardo Antezana-Muñoz
Software: Carlos Daniel Echazu Torres
Supervision: Carlos Alberto Paz-Román
Validation: Freddy Ednildon Bautista-Vanegas.
Visualization: Carlos Daniel Echazu Torres
Writing – original draft: Carlos Alberto Paz-Román, Jhossmar Cristians Auza-Santivañez, Carlos Daniel Echazu Torres, Freddy Ednildon Bautista-Vanegas, Daniel Ramiro Elías Vallejos-Rejas, Henrry Temis Quisbert-Vasquez, Jose Bernardo Antezana-Muñoz, Giovanni Callizaya Macedo, Mildred Ericka Kubatz La Madrid.
Editing – review and editing: Carlos Alberto Paz-Román, Jhossmar Cristians Auza-Santivañez, Carlos Daniel Echazu Torres, Freddy Ednildon Bautista-Vanegas, Daniel Ramiro Elías Vallejos-Rejas, Henrry Temis Quisbert-Vasquez, Jose Bernardo Antezana-Muñoz, Giovanni Callizaya Macedo, Mildred Ericka Kubatz La Madrid.