Espirales
Revista multidisciplinaria de investigación científica

Current Analysis of Monkeypox: Global Dynamics, Transmission, and Health Responses

Análisis actual de la viruela símica: dinámicas globales, transmisión y respuestas sanitarias

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Received: July 13, 2024
Approved: September 22, 2024

Quinatoa, M., Fierro, S., Quinatoa, E., Quinatoa, N. (2025) Current Analysis of Monkeypox: Global Dynamics, Transmission, and Health Responses. *Espirales Revista Multidisciplinaria de investigación científica*, *9* (1), 1-19

Abstract

Monkeypox, caused by the Monkeypox virus, is a zoonotic disease first identified in Africa in 1958. In recent years, it has transitioned from an endemic disease in Central and West Africa to a global concern due to outbreaks in non-endemic regions such as Europe, the Americas, and Asia. This study examines the recent evolution of monkeypox, focusing on its epidemiological changes, transmission mechanisms, and implemented control strategies. A systematic review of scientific literature published in databases such as PubMed, Scopus, SciELO, and Google Scholar was conducted. The findings are organized into three main areas: (1) epidemiology, highlighting the increase in cases in non-endemic regions; (2) transmission, emphasizing human-to-human spread through close contact and specific networks; and (3) control strategies, including informational campaigns, contact tracing, and vaccination. The results underscore the importance of strengthening global epidemiological surveillance and designing non-stigmatizing interventions that account for the social dynamics and transmission patterns of the virus. This analysis provides valuable insights for preventing the global spread of monkeypox and minimizing its public health impacts.

Keywords: Orthopoxvirus infection, Mpox, Monkeypox, Simian pox.

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Resumen

La viruela símica, causada por el virus Monkeypox, es una enfermedad zoonótica identificada por primera vez en África en 1958. En los últimos años, ha pasado de ser una enfermedad endémica en regiones de África Central y Occidental a convertirse en una preocupación global debido a la aparición de brotes en regiones no endémicas, como Europa, América y Asia. Este estudio analiza la evolución reciente de la viruela símica, enfocándose en sus cambios epidemiológicos, mecanismos de transmisión y las estrategias de control aplicadas. Se realizó una revisión sistemática de literatura científica publicada en bases de datos como PubMed, Scopus, SciELO y Google Académico. Los resultados se organizan en tres ejes principales: (1) epidemiología, destacando el aumento de casos en regiones no endémicas; (2) transmisión, con un énfasis en el contagio humano a través de contactos cercanos y redes específicas; y (3) estrategias de control, como campañas informativas, rastreo de contactos y vacunación. Los hallazgos subrayan la importancia de fortalecer la vigilancia epidemiológica global y diseñar intervenciones no estigmatizantes que consideren las dinámicas sociales y de transmisión del virus. Este análisis proporciona información valiosa para prevenir la propagación global de la viruela símica y minimizar sus impactos en la salud pública.

Palabras clave: Infección por Ortopoxvirus, Mpox, Viruela de los Simios, Viruela de los monos

Introduction

Monkeypox, also known as monkeypox, is a zoonotic disease caused by the Monkeypox virus, belonging to the genus Orthopoxvirus of the family Poxviridae. It was first identified in laboratory primates in 1958, and the first human case was reported in 1970 in the Democratic Republic of Congo (WHO, 1980). For decades, monkeypox was considered a disease confined to rural regions of Central and West Africa, where human contacts with reservoir animals, such as rodents and primates, facilitated its spread (Roig, 2022). However, recent years have shown a significant change in its dynamics, making it a global concern.

After the eradication of human smallpox in 1980 and the cessation of vaccination against this disease, global immunity to orthopoxviruses decreased considerably. This created an immunological niche that favored the transmission of monkeypox virus in humans (Metropolitan, 2024). This phenomenon, combined with factors such as deforestation, urbanization, and increased international travel, has intensified exposure to the virus and its spread in non-endemic regions (Davis, 2024). The 2022 outbreak marked a turning point when it was reported in non-endemic countries such as the United States,

Spain and Brazil, reaching more than 90,000 confirmed cases and 660 deaths worldwide by the end of that year (WHO, 2023).

Transmission of the virus is complex and includes direct and indirect routes. It can be spread through body fluids, skin lesions and contaminated fomites, as well as by respiratory droplets in close contact settings. In addition, the virus can be transmitted from mother to child during childbirth or breastfeeding (Roig, 2022). During recent outbreaks, a high prevalence of transmission was identified in sexual contact networks, particularly among men who have sex with men (Davis, 2024). These dynamics highlight the importance of addressing prevention in a non-stigmatizing and evidence-based manner.

The incubation period for monkeypox ranges from 6 to 13 days, with a range that can extend up to 21 days. Symptoms include fever, headache, myalgia, and lymphadenopathy, followed by a skin rash that progresses through macular, papular, vesicular, and pustular phases before crusting over. Although most cases resolve without medical intervention, complications can be serious, especially in immunocompromised individuals or those with comorbidities such as HIV. These complications include encephalitis, secondary bacterial infections, and pneumonia (Ravin, 2022).

The global response to recent outbreaks has been multifaceted. Prevention measures recommended by WHO include the use of masks, frequent hand washing, and surface disinfection (Ravin, 2022). In addition, JYNNEOS® and ACAM2000® vaccines have shown efficacy in preventing infections in high-risk populations, while antivirals such as Tecovirimat and Brincidofovir are used to manage severe cases (Fox et al., 2023). However, the unequal distribution of these resources has highlighted inequities in the global capacity to respond to health emergencies (WHO, 2023).

Advances in genomic analysis of the virus have been critical to understanding its evolution. During the 2022 outbreak, new lineages, such as B.1, were identified that exhibit increased transmissibility (Luna et al., 2022). These findings underscore the need for constant epidemiological surveillance and international collaboration to adjust control strategies. In addition, the ability to adapt quickly to changes in transmission dynamics is crucial to minimize the impact of future outbreaks.
In this perspective, the objective of this research is to analyze the evolution of monkeypox (Monkeypox) from its emergence as an endemic zoonotic disease in Africa to its emergence as a global threat in recent years. This analysis focuses on epidemiological changes, transmission mechanisms and control strategies implemented during recent outbreaks. By examining the dynamics of spread, public health responses, and innovations in diagnosis and treatment, this research seeks to provide a comprehensive view of current challenges and opportunities for improved disease management. It also seeks to highlight the importance of strengthening surveillance systems, promoting equitable access to preventive and therapeutic interventions, and fostering international collaboration to prevent future health emergencies related to this virus.

Materials and methods

The methodology used in this study is systematic in nature and is framed within a descriptive qualitative approach. The methodological process began with an exhaustive and rigorous review of the scientific literature related tomonkeypox(Monkeypox), with the aim of identifying and analyzing relevant information on the evolution of the disease, its epidemiological characteristics, transmission mechanisms and control strategies. To carry out this review, multiple academic databases and sources recognized for their reliability and relevance in the field of public health were used. Databases consulted included PubMed, SciELO, Elsevier, ScienceDirect, and Google Scholar, in addition to reports issued by international organizations such as the Pan American Health Organization (PAHO), the World Health Organization (WHO), and the Ministry of Public Health (MOH). These sources were selected for their ability to provide up-to-date, accurate and peer-reviewed information.

The scientific literature search was structured using descriptors in Health Sciences (DeCS) and MeSH (Medical Subject Headings) terms, which allowed accurate retrieval of information in the databases. The terms used included "Monkeypox", "Epidemiology of monkeypox", "Transmission of zoonotic diseases" and "Emerging disease control strategies". To improve the completeness of the analysis, Boolean operators such as AND and OR were applied, which made it possible to combine key terms and broaden the coverage of the search.

The documentary approach of this research allowed focusing the analysis on theoretical aspects related to monkeypox, prioritizing those studies and papers that specifically addressed its recent evolution and global impact. The inclusion criteria were carefully defined to ensure the relevance of the selected articles. We included studies published between 2000 and 2023, written in English or Spanish, that addressed monkeypox from a clinical, epidemiological or health policy perspective. On the other hand, we excluded papers that did not provide analyses on the evolution of the disease or that focused exclusively on other viruses of the Orthopoxvirus family.

Once the relevant papers were identified, a selection and filtering process was performed. This included reading titles and abstracts to ensure that the studies met the established criteria. Subsequently, a comprehensive reading of the full texts was carried out to extract relevant information and consolidate it in an analysis matrix designed specifically for this study. The matrix made it possible to organize the data according to the categories of interest: epidemiology, transmission and control strategies. To ensure the quality and rigor of the included studies, critical appraisal tools were used, such as checklists for qualitative studies and guidelines for systematic reviews. This ensured that the information extracted was reliable and applicable to the objective of the study.

The methodological approach allowed the integration of multidimensional knowledge on monkeypox, identifying patterns and trends in its global evolution. Likewise, the

systematization of the data collected favored the development of a critical and in-depth analysis, which provided a comprehensive view on the current and future challenges related to this emerging disease.

Results

Overview of monkeypox: epidemiology and transmission.
Simian pox, known as Monkeypox in English, is a zoonosis endemic to the jungle areas of central and western Africa (Alvarez and Jaramillo, 2023). This virus, belonging to the genus Orthopoxvirus of the family Poxviridae, is one of the largest and most complex viruses known. Its brick-shaped particles are 220-450 nm long and 140-260 nm wide, allowing them to be observed with optical microscopes and analyzed in detail by electron microscopy. These particles are composed of four main elements: nucleus, lateral bodies, membrane and an external lipoprotein envelope (Gómez, 2022).

The first documented human case of simian smallpox was reported in 1970 in the Democratic Republic of Congo. Since then, the virus has been prevalent in several regions of Central and West Africa. Although primates were initially believed to be the main reservoirs of this virus, recent studies have identified small mammals, such as rodents, squirrels and giant rats, as the most likely carriers and responsible for transmission (Chipana, 2022).

The World Health Organization (WHO) has emphasized that although monkeypox is usually self-limiting, there is low immunity in populations in non-endemic countries due to lack of previous exposure to the virus. Furthermore, the agency classifies the virus into two main clades: the West African clade, associated with milder disease, and the Central African clade, which has greater severity and a higher case fatality rate (WHO, 2024). This context underscores the need for global epidemiological surveillance to control its spread and mitigate its impacts.

Studies show that it can be transmitted through direct contact with infected animals as well as from person to person, this can be zoonotic or interhuman depending on the behavior of the community and its relationships.

The main method of transferring this Monkeypox virus is from animals to people, which is known as zoonosis, these are found in Central and West Africa. When spread from animal to person, it can be transferred immediately through mammalian bites, scratches as well as by contact with contaminated blood or secretions, while having contact with lesions or wounds of the infected person, and can also be spread by wearing clothing, touching infected materials. Although it is less common, it can also be transmitted by respiratory droplets and this can occur when there is prolonged exposure, especially in closed places. Another way of transmission is by talking, coughing or sneezing, in this case viral particles in saliva or secretions can be spread especially in the first days of the disease when the virus is present in the upper respiratory tract.
The latest studies indicate that most people infected with this virus are homosexual individuals having unprotected sex, but it is not yet considered a sexually transmitted infection. It has also been shown that a mother during labor and delivery can also pass this virus to her newborn, resulting in congenital MPOX, as well as during

breastfeeding.

The carrier of this type of disease immediately becomes a carrier of the virus presenting prodromal symptoms such as fever, headache, fatigue and malaise, being more evident the lesions or rashes on the skin while these wounds are not healed will continue to be contagious to their surroundings.

The incubation period of this virus can vary between 5 to 21 days, but generally it is from 6 to 13, while this time does not pass the person does not show symptoms, but once the fever and the first outbreaks appear the person becomes highly contagious in many occasions this disease can be mild however it can present symptoms such as encephalitis or secondary infections, being more prone to vulnerable people and children.

These factors include biological risks, which include the presence of vectors and pathogenic microorganisms; environmental risks such as lack of drinking water, poor sanitary conditions and proximity to wildlife areas; and behavioral risks, which include cultural, hygienic and dietary practices that may encourage disease transmission. Africa is one of the continents most affected by monkeypox due to several factors, including poor feeding practices, since in its different countries they engage in dangerous hunting of animals (lion, leopard, rhinoceros, buffalo, and elephant), and nowadays they have even incorporated hippopotamus and crocodile. In addition, they also feed on antelope, swine and zebra. In this scenario, the sum of these variables increases the susceptibility of the population to outbreaks of infectious diseases, such as the aforementioned virus. The hunting of these animals is also used to obtain different organs as it is believed to serve as a treatment and cure for some diseases.

The disease can be diagnosed by isolating the virus from the blood or lesions, or by identifying the antibodies in the blood that have been produced in response to the virus, this analysis must be performed in specialized laboratories using appropriate testing techniques. The quality and type of specimen are critical for confirmation, being superficial swabs of exudates or crusts, as well as nasopharyngeal swabs and saliva. Also, nucleic acid amplification using conventional PCR or real-time PCR to find viral DNA sequences are most recommended. In people who do not show any symptomatology or visible lesions, it can be performed through oropharyngeal swabs.

In Ecuador, the National Institute of Public Health Research (INSPI) in Quito, Guayaquil, Cuenca and Tena, are in charge of testing for monkeypox diagnosis. This Public Health agency manages the arrest and confirmation of the disease through tests collected by professionals, following the protocols established by the Ministry of Public Health (MSP) and in coordination with the Pan American Health Organization (PAHO) to ensure an adequate response in the monitoring and control of outbreaks.
For virus confirmation, it is necessary to collect blood serum samples, skin lesion material (papule, pustule, vesicle), which should be done with Dacron swabs. The collected samples should not be mixed in the same tube and should be refrigerated (2 to 8°C) or frozen (-20°C) for one hour and transferred to the INSPI as soon as possible.

Several scientists indicate that there is no specific and approved treatment for monkeypox, however, there are some antiviral drugs that can help control this disease such as Tecovirimat (TPOXX) or Codofovir, Brincidofovir (Tembexa) and the vaccine . Tecovirimat. It is a 4-trifluoromethylphenol derivative that was approved as an antiviral candidate in 2018 by the Food and Drug Administration (FDA), but its commercialization in Europe occurred in early January 2022, this drug is composed of small molecules which interrupt the final steps of maturation and release of infected cells. Cidofovir. It acts by inhibiting the DNA polymerase of the virus and was approved in 1996 for the treatment of cytomegalovirus rhinitis in AIDS patients. There are also studies indicating efficacy against Orthopoxvirus and lethal infections of simian smallpox.

MVA-BN vaccine (Modified Vaccinia Ankara-BavarianNordic). It is a type of viral vector vaccine that is based on a modified vaccinia virus strain to prevent its reproduction in human cells, which makes it safe and effective in creating a stable immune response to the first clade pathology, which has been used in vulnerable groups that have been exposed to this virus reducing it by 62% to 85%, it is even effective for children, it presents side effects such as: algia, erythema, edema and pruritus, some people have headache, asthenia, emesis and tremors. This vaccine was also approved by the FDA in the United States and the Ema in Europe. For its treatment, two doses are given to boost its immunology.

LC16m8. It is an attenuated version of the smallpox application, created in Japan, which uses a modified strain of the vaccinia virus to reduce adverse effects, particularly in people with weakened antiviral systems or at risk of complications. Its elimination procedure enables treatment to be effective without the dangers associated with conventional, more potent live virus vaccines such as the Dryvax vaccine, and is used as a preventive strategy.

ACAM 2000. It is an anti-rabies ampoule created from the vaccinia virus similar to the different doses with the same purpose, with a difference that includes a live virus that can replicate becoming more effective providing a robust and lasting response, this presents more adverse effects compared to other vaccines reaching the point that can cause heart and blood vessels affections besides it is not recommended to pregnant, breastfeeding and close women.

It is recommended that most of the patients already identified comply with the general preventive measures in a home and health care environment. Patients should remain in isolation at home until all symptoms have been eliminated, skin lesions have disappeared and scabs have disappeared. At the same time, due to the increased risk of spread of the current outbreak that is related to sexual practices, more attention should be paid.

Home isolation of a patient with monkeypox should include separation from other family members and pets, use of a separate bathroom, care of the infected person's lesions to prevent their spread, keeping a meter distance from everyone, avoiding contact with

children, pregnant women and immunocompromised persons, practicing proper hand hygiene, wearing a mask if there are respiratory symptoms, covering the lesions with long clothing, not wearing contact lenses, not shaving the affected areas. It is essential to disinfect surfaces frequently, with solutions such as 0.1% sodium hypochlorite, wash contaminated clothing with water at 70° Celsius degrees, frequently use gloves, surgical masks when in contact with affected surfaces. Do not share personal or household objects and avoid sexual intercourse, even with barrier methods, for 8 to 12 weeks until complete recovery.

Prevention strategies for smallpox include a combination of health education, effective communication and community actions to minimize the spread of the virus and ensure the adoption of preventive practices. Health professionals play a central role in this effort by developing and distributing educational materials designed to inform and sensitize the population. These materials include posters, brochures, informational posters, short videos, and the installation of stands in strategic locations such as markets, schools, and health centers (Madrigal et al., 2022). These educational resources aim to provide clear information on the ways in which the virus is transmitted, the most effective prevention measures, and the importance of seeking timely medical care.

The design of these materials should take into account the cultural and linguistic context of the targeted communities. For example, in rural or hard-to-reach areas, the use of illustrative images can be crucial to overcome language barriers. Likewise, in urban areas, the use of social media and digital campaigns can significantly expand the reach of these strategies, especially among young people. Key messages should include information on personal hygiene, such as frequent hand washing, correct use of masks, and disinfection of surfaces, as well as specific recommendations on the management of skin lesions and the importance of isolation for infected patients. A community approach is equally important. Health promoters, who are trained members of the community, can act as effective intermediaries to disseminate information and build trust. These promoters not only help distribute educational materials, but also organize workshops, lectures and meetings in which they answer questions and clarify misconceptions about the disease. Their proximity to the community facilitates understanding and acceptance of the proposed preventive measures.

In addition, collaboration with community, religious and local leaders can strengthen the effectiveness of campaigns. For example, integrating prevention messages into community events, religious ceremonies and neighborhood meetings can increase the visibility of these initiatives and encourage the active participation of the population. Another essential component is the use of mass media, such as radio and television, especially in regions with limited Internet access. These platforms can transmit brief but powerful messages, alerting about the initial symptoms of the disease, the importance of not stigmatizing infected people and the steps to follow in case of suspected infection.

Finally, prevention strategies should also include drills and practical exercises in health centers and hospitals to ensure that medical personnel are prepared to handle possible cases of smallpox. This includes training in biosafety protocols, proper use of personal protective equipment, and identification and follow-up of close contacts of patients. In summary, smallpox prevention strategies require a comprehensive approach that combines health education, community mobilization, and effective use of the media. These coordinated actions not only help to reduce transmission of the virus, but also strengthen the resilience of communities in the face of possible future outbreaks. Analysis of recent cases

In 2022, WHO declared monkeypox a global health emergency due to unexpected outbreaks in non-endemic countries. Africa remains the most affected region, with a high incidence among children under 15 years of age. In Latin America, countries such as Brazil, Mexico and Peru have reported significant increases in diagnosed cases. In Ecuador, the first case was reported in July 2022, and by the end of that year, 244 cases had been confirmed with a predominant distribution in Pichincha and Guayas (Castillo, 2022; Aragon, 2023).

In recent months, new cases of monkeypox have been reported worldwide, although with less intensity. Africa continues to be the area most affected by monkeypox with numerous infections, in nations such as the Republic of Congo, Burundi and Rwanda, it was observed that children are the most vulnerable with 60% of the cases reported among children under 15 years of age (Castillo, 2022).

According to the United Nations (UN), 7892 cases were reported globally, 78% of which corresponded to men between 18 and 44 years of age, 98% were identified in homosexual men, 41% of whom had HIV-AIDS, 7 cases in children under 18 years of age in African and European countries, and health personnel were also affected, with the disease appearing in 113 workers.

In Latin America, there was an increase in the number of people infected with smallpox, 449 cases were diagnosed in Brazil, 126 in Peru, 40 in Mexico, 26 in Chile, 13 in Argentina, 7 in Colombia, 1 in Barbados and 1 in Panama, with young people and a small number of infants being the most affected.

In July 2022, Ecuador confirmed its first case of monkeypox in a 30-year-old man with a history of travel to Europe, who presented with fever, skin lesions, features and general malaise. The patient was diagnosed in Quito, was stable, under isolation in Guayas as were those with whom he had contact. On July 19, the second case was reported in a 27-year-old patient, who was identified at the Eugenio Espejo Hospital in Quito. By July 22, 2022, a third case was reported in a man of Ecuadorian nationality residing in Quito, who also had contact with foreigners since he did not leave the country. In Ecuador, since the report of the first case of monkeypox on July 6, 2022, up to epidemiological week 42, 244 confirmed cases of monkeypox have been reported, with one death in the province of Guayas; 89% of these cases are male and 11% are female; the patients who underwent sequencing were found to have West African clade II. According to the distribution by provinces, Pichincha had the highest percentage of

cases, 40%, followed by Guayas with 33%, with cases occurring in 17 of 24 provinces. In a month and a half the cases of monkeypox increased rapidly resulting in 405 cases out of 243 with an increase of 162 cases, Pichincha remained the province with high infections and recorded 155, followed by Guayas with 136, Cotopaxi like other provinces was found with fewer infections 31, Azuay 22, Tungurahua with 12, Imbabura 10, Santo Domingo de Tsáchilas 8, Chimborazo 6, Manabí 5, El Oro 4, Santa Elena 4, Esmeraldas and Loja 3, Carchi 2, and in Cañar, Sucumbíos, Los Ríos and Zamora Chinchipe one infection was identified respectively. For week 48, 5 new cases of monkeypox increased in Pichincha, 3 in Guayas, 2 in Cotopaxi and one in Azuay, Tungurahua, Santo Domingo de los Tsáchilas and Chimborazo. Of the 405 confirmed cases, 159 were discharged and 262 remained under epidemiological surveillance.
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In 2023, health authorities continued to carry out epidemiological surveillance in order to monitor and regulate the potential spread of monkeypox. This meant that observation and reporting tactics were implemented to quickly identify any new cases. Despite these prevention efforts, seven individuals were reported to be infected with the virus, which is evidence that, despite the fact that the scenario was being monitored, the virus managed to infect certain individuals. Monitoring facilitated the identification of these infections and potentially their early treatment to prevent further spread. During the last few months in Ecuador, five cases of monkeypox belonging to the Monkeypox clade II strain were identified by PCR technique through tests conducted by the National Institute of Public Health Research (INSPI).
On August 22, 2024, the Undersecretary of Health Surveillance and Prevention stated that three infected persons have not traveled abroad and are therefore autochthonous cases, they are located in the provinces of Los Rios and Pichincha.

Conclusions

Monkeypox has evolved from an endemic zoonosis restricted to regions of Central and West Africa to a global public health concern following outbreaks in non-endemic countries since 2022. This shift highlights the vulnerability of populations lacking natural immunity to the virus and underscores the need for a thorough understanding of its transmission dynamics to prevent and control future outbreaks.
Preventive strategies have proven to be essential in the fight against this disease. Measures such as isolation of infected patients, vaccination and educational campaigns have played a key role in containing its spread. However, it is crucial to avoid approaches that may stigmatize certain population groups. At the same time, these strategies should focus on reaching the most vulnerable communities, especially those facing limited access to basic health services.

The development of antiviral treatments such as Tecovirimat and Brincidofovir represents a significant advance in the clinical management of severe cases. Despite these achievements, the need for additional research to develop more accessible and effective treatments remains a priority. Similarly, ensuring rapid and accurate diagnostics through the implementation of specialized laboratories and training of

healthcare workers is essential to improve the management of current and future outbreaks.

Epidemiological surveillance has proven to be an indispensable tool in the containment of monkeypox. Early detection and rapid response have been critical in curbing the spread of the virus. Expanding these capabilities, especially in regions with limited health systems, is a necessary step to strengthen the global response to this disease. International cooperation emerges as an essential component in the fight against monkeypox. The exchange of epidemiological data, technical and financial support to countries with limited resources, and collaboration in scientific research and technological development are crucial to effectively address this health emergency. A coordinated global response will make it possible not only to manage current outbreaks, but also to prevent future resurgences.

It is essential to strengthen health systems to make them more equitable and resilient to health emergencies. In addition, awareness campaigns must be culturally sensitive and accessible, promoting a proper understanding of the disease and its prevention measures. Initiatives should prioritize the development of affordable diagnostic tools, antivirals and vaccines to ensure an inclusive and sustainable response.
In conclusion, monkeypox poses significant global public health challenges, especially in regions with fragile health systems. Tackling this disease effectively requires a combination of preventive strategies, scientific advances, and strong international collaboration. With a comprehensive approach, it is possible to reduce the public health impact of this disease and prevent its re-emergence in new areas.

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