Ebola Virus Disease: Epidemiology, Public Health Prevention Strategies, and Global Health Implications

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ABSTRACT

Ebola virus disease is one of the most severe emerging infectious diseases affecting global health security. Since its first recognition in 1976, Ebola virus disease has caused recurrent outbreaks, mainly in sub-Saharan Africa, with substantial mortality, social disruption, and health system burden. The disease is caused by viruses within the family *Filoviridae* and is associated with zoonotic spillover, human-to-human transmission, and high case fatality rates. The 2014–2016 West African epidemic demonstrated the devastating consequences of delayed surveillance, weak health infrastructure, inadequate infection prevention and control, and poor community trust. At the same time, the epidemic accelerated advances in outbreak preparedness, diagnostics, vaccination, therapeutics, and global health security. This narrative review examines the epidemiology, clinical presentation, diagnosis, prevention strategies, treatment approaches, and broader global health implications of Ebola virus disease. The review also highlights the importance of the One Health approach, health equity, community engagement, and sustained public health investment in preventing future outbreaks.

Keywords: Ebola virus disease, epidemiology, outbreak prevention, public health, global health security, One Health

INTRODUCTION

Ebola virus disease is a severe zoonotic viral infection caused by viruses in the genus *Ebolavirus* within the family *Filoviridae* [6,7]. The disease is associated with high mortality, rapid human-to-human transmission after symptom onset, and serious disruption of healthcare systems and communities [2,8,9]. Ebola has become a major symbol of the threat posed by emerging and reemerging infectious diseases, especially in settings where surveillance systems, laboratory capacity, and healthcare infrastructure are limited [1,10].

The first recognized Ebola outbreaks occurred in 1976 in what the Democratic Republic of the Congo and South Sudan is now. Since then, outbreaks have occurred mainly in Central and West Africa, with variation in size, location, case fatality, and public health response [2,7,8]. The 2014–2016 West African epidemic was the largest Ebola outbreak ever recorded and affected Guinea, Liberia, and Sierra Leone. It exposed serious weaknesses in national health systems and international preparedness while also demonstrating the importance of strong surveillance, rapid diagnosis, community trust, infection prevention, and global coordination [3,4,31,32].

Ebola virus disease is not only a biomedical problem. It is also shaped by ecological, social, political, economic, and health system factors [1,3,11]. Deforestation, human encroachment into forested areas, wildlife contact, cross-border movement, poverty, weak health systems, and mistrust of authorities can all influence the risk and scale of outbreaks [11,12,30]. Therefore, Ebola prevention requires a One Health approach that recognizes the connection between human, animal, and environmental health [1,10,12].

METHODOLOGY

This article was developed as a narrative review of scientific and public health literature on Ebola virus disease. Relevant sources included peer-reviewed articles, public health reports, and guidance documents from the World Health Organization, Centers for Disease Control and Prevention, and European Center for Disease Prevention

and Control [2,9,13]. The review focused on literature on Ebola epidemiology, virology, ecological origins, clinical features, diagnosis, outbreak prevention, infection control, vaccination, therapeutics, community engagement, survivor care, and global health security.

Search concepts included Ebola virus disease, Ebola epidemiology, One Health, filoviruses, Ebola diagnostics, outbreak response, infection prevention and control, safe burial practices, Ebola vaccination, Ebola therapeutics, and global health preparedness. Publications from 2010 to 2026 were prioritized when possible, although earlier landmark studies were included for historical and scientific relevance [12,14,27]. Because this is a narrative review, findings were synthesized descriptively rather than quantitatively. A formal systematic review process and risk-of-bias assessment were not performed.

Virology and Ecological Origin

Ebola viruses are filamentous, negative-sense RNA viruses belonging to the family *Filoviridae* [6,7,15]. Several species of *Ebolavirus* are known to cause disease in humans, including Zaire ebolavirus, Sudan virus, Bundibugyo virus, and Taï Forest virus [6,7,15]. Zaire ebolavirus has been responsible for many of the largest and deadliest outbreaks, including the 2014–2016 West African epidemic and several outbreaks in the Democratic Republic of the Congo [4,7,8].

Fruit bats are considered the most likely natural reservoir of Ebola viruses, although the full ecology of Ebola transmission remains complex [12]. Human infection may occur through contact with infected wildlife, including bats or nonhuman primates, or through handling, hunting, butchering, or consuming bushmeat [1,11,12]. Once the virus enters the human population, it spreads through direct contact with blood, body fluids, tissues, organs, or contaminated surfaces of symptomatic infected individuals [2,8,9].

Environmental and ecological changes may increase the risk of Ebola spillover. For example, loss of closed forests has been associated with Ebola virus disease outbreaks, suggesting that deforestation and human expansion into forested ecosystems may create more opportunities for contact between humans and infected wildlife [11]. This supports the One Health approach, which emphasizes that human health is closely connected with animal health and environmental conditions [1,10,11].

Clinical Features and Pathophysiology

The incubation period of Ebola virus disease is usually 2 to 21 days [2,8,16]. Early symptoms are often nonspecific and may include fever, fatigue, headache, muscle pain, sore throat, and weakness [8,16,17]. Because these symptoms resemble malaria, typhoid fever, influenza, and other febrile illnesses, early cases may be missed, especially in regions with limited diagnostic capacity [17,18,20].

As the disease progresses, patients may develop vomiting, diarrhea, abdominal pain, rash, conjunctivitis, impaired liver and kidney function, and, in some cases, internal or external bleeding [7,8,17,18]. Severe Ebola virus disease is associated with immune dysregulation, endothelial dysfunction, vascular leakage, coagulation abnormalities, shock, and multi-organ failure [5,7,8]. Death often results from severe dehydration, electrolyte imbalance, shock, and organ failure rather than bleeding alone [5,8,19].

Clinical management depends on early recognition, isolation, supportive care, and treatment of complications [18,19]. Supportive care includes fluid replacement, electrolyte correction, oxygen support, blood pressure support, treatment of secondary infections, and management of organ dysfunction [18,19]. Early clinical care improves survival, especially when patients are diagnosed and treated before severe complications occur [19,21].

Diagnosis and Laboratory Testing

Rapid and accurate diagnosis is essential for controlling Ebola outbreaks. Because early symptoms are nonspecific, laboratory confirmation is necessary to distinguish Ebola virus disease from malaria, typhoid fever, Lassa fever, Marburg virus disease, and other infectious diseases [14,17,23]. Reverse transcription polymerase chain reaction testing is considered a key diagnostic method for detecting Ebola virus RNA, especially during outbreaks [14,23,26].

Point-of-care and rapid diagnostic tests can support outbreak response by improving access to testing in field settings and reducing delays in case identification [24]. However, laboratory testing for Ebola requires strict biosafety procedures because patient specimens may contain infectious virus [23,26,27]. Safe specimen collection, transport, processing, and waste management are essential to protect healthcare and laboratory workers [23,25–27].

Strong laboratory networks are a core part of outbreak preparedness. Countries at risk for Ebola outbreaks need trained laboratory personnel, diagnostic supplies, quality assurance systems, and clear reporting mechanisms so that suspected cases can be confirmed rapidly and response teams can act quickly [23,25,26].

Epidemiology of Ebola Virus Disease

Ebola outbreaks have occurred primarily in Central and West Africa, with substantial differences in outbreak size and case fatality [2,7,8]. Earlier outbreaks were often smaller and geographically contained, but the 2014–2016 West African epidemic demonstrated that Ebola can spread widely when health systems are weak, and response is delayed [4,28,32].

The 2014–2016 epidemic caused major health, social, and economic disruption in Guinea, Liberia, and Sierra Leone [3,4,28]. Several factors contributed to the scale of the epidemic, including delayed recognition, limited surveillance, weak laboratory capacity, shortages of healthcare workers, inadequate infection prevention and control, unsafe burial practices, population movement, and mistrust of authorities [3,4,28,32,33].

Healthcare workers are among the highest-risk groups during Ebola outbreaks because of close contact with infected patients and body fluids [31,42]. Inadequate personal protective equipment, insufficient training, and weak infection prevention systems can increase occupational risk and contribute to healthcare-associated transmission [27,31,37]. Protecting healthcare workers is therefore essential for both outbreak control and health system stability [31,37,42].

Population movement and transportation networks can also influence Ebola spread. Although Ebola transmission requires direct contact with infected body fluids, travel within and across borders can introduce cases into new communities before an outbreak is recognized [30]. This makes cross-border surveillance, rapid communication, and regional preparedness especially important [30,34].

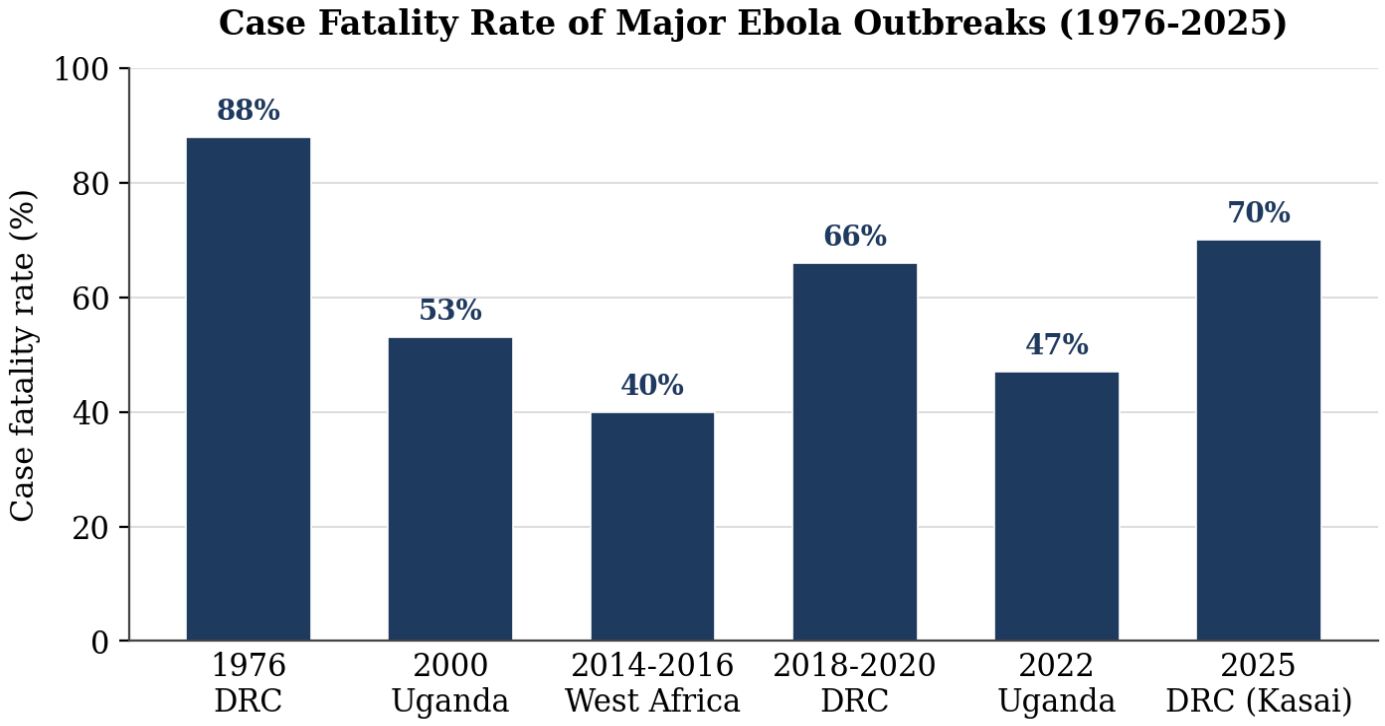


Figure 1. Case fatality rates of selected Ebola outbreaks, 1976–2025.

Insert figure here. This figure should compare case fatality rates across selected outbreaks and show that mortality varies by virus species, setting, healthcare capacity, and response speed.

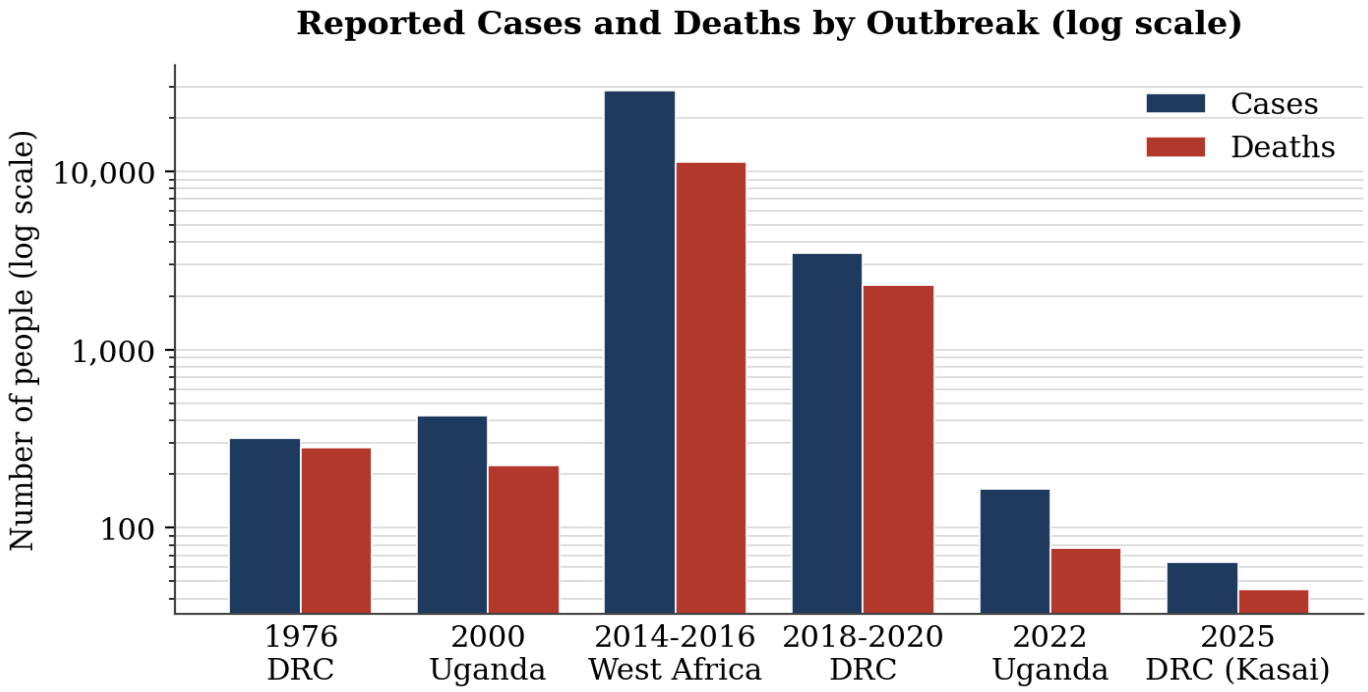


Figure 2. Reported Ebola cases and deaths by major outbreak.

Insert figure here. This figure should show that the 2014–2016 West African epidemic was much larger than previous outbreaks and had major implications for global health preparedness.

Determinants of Transmission

Ebola transmission is shaped by biological, social, cultural, ecological, and health system determinants [1,3,11]. Important risk factors include direct care for infected patients, contact with body fluids, unsafe burial practices, healthcare exposure, poor infection control, delayed diagnosis, and limited community awareness [2,8,27,33,37].

Traditional burial practices are particularly important in Ebola epidemiology. In many affected communities, funeral rituals may involve washing, touching, or kissing the body of the deceased. Because people who die from Ebola can have high viral loads, unsafe burials can produce multiple secondary infections [33,38]. Safe and dignified burial practices are therefore necessary to reduce transmission while respecting cultural and religious values [33,38].

Community trust also plays a central role in outbreak control. Mistrust, misinformation, fear, and historical experiences of neglect or conflict can reduce cooperation with public health measures [40]. When communities do not trust response teams, people may avoid testing, hide sick relatives, resist contact tracing, or reject vaccination [40]. For this reason, public health response must include transparent communication, local leadership, and culturally respectful engagement [36,40].

Conflict and political instability can further complicate Ebola control. In insecure settings, response teams may be unable to safely conduct surveillance, contact tracing, vaccination, or burial activities [34,36,40]. These challenges demonstrate that Ebola is not only a medical emergency but also a governance and social trust challenge [3,44,45].

Figure 3. Transmission and control pathway of Ebola virus disease.

Insert figure here. This figure should show the pathway from animal reservoir and zoonotic spillover to human-to-human transmission, healthcare exposure, funeral exposure, and public health control strategies.

Public Health Prevention and Control Strategies

Surveillance and Early Warning Systems

Surveillance is the foundation of Ebola prevention and outbreak control [2,34]. Effective surveillance systems detect unusual illness clusters, support rapid reporting, and trigger immediate investigation [34]. Community-based surveillance, event-based surveillance, and laboratory-supported surveillance are all important for early detection [23,26,34].

Early warning systems are especially important in high-risk areas where Ebola outbreaks have occurred previously or where ecological and social conditions increase the risk of spillover [1,11,34]. Surveillance systems must be linked to rapid response capacity, including diagnostic testing, case isolation, contact tracing, safe transport, infection prevention, and community communication [25,26,34].

Contact Tracing

Contact tracing is one of the most important tools for interrupting Ebola transmission [35,36]. It involves identifying people who have been exposed to a confirmed or probable case and monitoring them for 21 days, which is the maximum incubation period [2,35,36]. If a contact develops symptoms, they can be isolated and tested quickly, reducing the risk of further transmission [35,36].

The success of contact tracing depends on trained staff, accurate data systems, transportation, security, and community cooperation [35,36]. In large outbreaks, contact tracing may become difficult because of high case numbers, population movement, stigma, and mistrust [35,40]. Therefore, contact tracing should be combined with risk communication and community engagement [36,40].

Infection Prevention and Control

Infection prevention and control measures are essential in healthcare settings [27,37]. These measures include hand hygiene, use of personal protective equipment, safe injection practices, patient isolation, environmental cleaning, waste management, and safe handling of contaminated materials [27,37]. Proper infection control protects healthcare workers and prevents healthcare facilities from becoming centers of transmission [27,31,37].

Healthcare worker infections during Ebola outbreaks can weaken health systems and reduce public confidence in healthcare services [31,42]. Training healthcare workers before and during outbreaks is therefore critical. Preparedness should include regular infection prevention training, adequate supplies of protective equipment, clear triage protocols, and safe systems for transporting suspected cases [27,37].

Safe and Dignified Burial Practices

Safe and dignified burial practices reduce the risk of transmission from deceased Ebola patients while respecting cultural and religious traditions [33,38]. Because contact with bodies can transmit Ebola, burial teams must use protective equipment and follow safe body handling procedures [33,38]. At the same time, families should be allowed to mourn in ways that do not involve unsafe physical contact [38].

Public health teams should work with religious leaders, traditional leaders, and community representatives to design burial practices that are both safe and acceptable [38,40]. This approach reduces resistance and supports trust between communities and response teams [40].

Vaccination

Vaccination has become an important tool in Ebola outbreak control. The rVSV-vectored vaccine demonstrated efficacy and effectiveness against Zaire ebolavirus disease and has been used in ring vaccination strategies [39]. Ring vaccination targets contacts and contacts of contacts around confirmed cases, creating a protective barrier that helps interrupt transmission [39].

However, vaccine protection is not universal across all Ebola virus species. Current licensed vaccines mainly target Zaire ebolavirus and may not protect against other species such as Sudan virus or Bundibugyo virus [6,7,39]. Continued research is needed to develop broader vaccines and improve preparedness for non-Zaire Ebola virus outbreaks [6,10,21].

Treatment and Therapeutics

For many years, Ebola treatment relied mainly on supportive care [18,19]. Supportive treatment remains essential and includes fluid resuscitation, electrolyte replacement, oxygen therapy, management of shock, and treatment of complications [18,19]. Early supportive care can improve survival, especially when patients are treated before severe dehydration or organ failure develops [19,21].

The PALM randomized controlled trial changed the treatment landscape by showing that monoclonal antibody therapies could reduce mortality among patients with Zaire ebolavirus disease [21]. These findings supported the use of targeted therapeutics and demonstrated the importance of rapid diagnosis and early treatment [21,47]. However, these therapies are mainly effective for Zaire ebolavirus and do not fully solve the need for treatments against other Ebola virus species [6,21,47].

Community Engagement and Risk Communication

Community engagement is central to Ebola outbreak control [36,40]. Public health interventions are more successful when communities understand the disease, trust response teams, and participate in prevention activities [40]. Community leaders, religious leaders, survivors, local health workers, and civil society organizations can help improve acceptance of surveillance, contact tracing, safe burials, vaccination, and treatment [36,38,40].

Misinformation can seriously undermine outbreak response. During Ebola outbreaks, rumors and fear may lead people to avoid healthcare facilities, hide symptoms, resist burial teams, or reject vaccination [40]. Therefore, risk communication must be transparent, culturally appropriate, and delivered in local languages [36,40]. Public health teams should listen to community concerns rather than only giving instructions [40].

Public Health Impact of Ebola

Ebola outbreaks affect more than infected individuals. They disrupt routine health services, reduce vaccination coverage, interrupt maternal and child healthcare, and delay treatment for conditions such as malaria, tuberculosis, HIV, and chronic diseases [41]. During large outbreaks, fear of healthcare facilities can prevent people from seeking care, leading to indirect deaths from non-Ebola conditions [41].

Healthcare worker mortality has long-term consequences for fragile health systems [31,42]. When doctors, nurses, and other health workers become infected or die, the healthcare workforce becomes weaker, and routine services may decline [42]. This impact can continue after the outbreak ends [41,42].

Survivors may experience long-term physical and psychological complications, including fatigue, joint pain, eye problems, hearing problems, headaches, depression, anxiety, stigma, and social isolation [22,43]. Ebola virus RNA may also persist in immune-privileged sites, including semen, which has implications for survivor counseling and sexual transmission prevention [43]. Survivor programs should therefore include medical follow-up, mental health support, reproductive health counseling, and anti-stigma interventions [22,43].

Socioeconomic Consequences

Ebola outbreaks create major economic and social consequences [3,41]. During the West African epidemic, affected countries experienced reduced trade, lower agricultural production, school closures, loss of income, increased household poverty, and disruption of national development [3,41]. Families affected by Ebola may face medical costs, funeral costs, loss of employment, caregiving burdens, and food insecurity [41].

At the national level, governments may be forced to redirect limited resources to emergency response, reduci-

ng investment in routine healthcare and other public services [3,41]. Ebola therefore represents not only a health crisis but also a development and equity challenge [3,44,45].

Global Health Security and Preparedness

The West African Ebola epidemic revealed major weaknesses in global health security [3,4,44]. Delayed international response, weak national health systems, inadequate emergency financing, and limited coordination contributed to the scale of the crisis [3,4,44]. In response, global health institutions emphasized the need for stronger surveillance, laboratory systems, emergency preparedness, workforce development, and international cooperation [44–47].

Health security requires strong national capacities as well as global coordination [44,47]. Countries must be able to prevent, detect, and respond to outbreaks quickly, while international organizations must provide technical support, financing, and coordination when outbreaks exceed national capacity [44,45]. Lessons from Ebola also informed preparedness for later global health threats, including COVID-19 [10,47].

Preparedness must be sustained between outbreaks. Public health investment often increases during emergencies and declines afterward, leaving countries vulnerable when the next outbreak occurs [4,29,46]. Long-term preparedness requires continuous financing for surveillance, laboratories, workforce training, community health systems, vaccines, therapeutics, and research [29,44,46].

DISCUSSION

This review demonstrates that Ebola virus disease is shaped by interactions among virology, ecology, clinical care, health systems, social behavior, and global governance. The virus itself is highly pathogenic, but the size and severity of outbreaks depend strongly on context [3,5,8]. Weak surveillance, delayed diagnosis, poor infection prevention, unsafe burials, community mistrust, and inadequate health system capacity can allow transmission to expand [3,4,27,33,40].

One of the most important lessons from Ebola is that health system strengthening is central to outbreak preparedness [3,44,47]. Countries with strong primary healthcare, trained health workers, functioning laboratories, and emergency response systems are more likely to detect and contain outbreaks early [34,44,47]. Ebola also shows that biomedical tools alone are not enough. Vaccines, diagnostics, and therapeutics must be supported by community trust, health equity, and public health infrastructure [21,39,40].

The One Health approach is also essential because Ebola emergence is connected to wildlife reservoirs, environmental change, and human behavior [1,10–12]. Preventing future outbreaks requires collaboration across human health, animal health, environmental science, and community development sectors [1,10,11].

This review has limitations. Because it is a narrative review, it does not include a formal systematic search strategy or risk-of-bias assessment. However, it provides a broad synthesis of the epidemiology, clinical features, prevention strategies, treatment options, and global health implications of Ebola virus disease.

RECOMMENDATIONS

1. Strengthen surveillance and early warning systems in high-risk countries [34].
2. Expand laboratory capacity and safe diagnostic testing for Ebola virus disease [14,23–26].
3. Improve infection prevention and control training for healthcare workers [27,31,37].
4. Maintain rapid contact tracing systems and community-based monitoring [35,36].
5. Support safe and dignified burial practices that respect cultural and religious values [33,38].
6. Expand vaccine research and preparedness for non-Zaire Ebola virus species [6,21,39].

7. Improve access to early supportive care and Ebola therapeutics [18,19,21].
8. Strengthen survivor care, including mental health support and reproductive health counseling [22,43].
9. Build community trust through transparent communication and local leadership [36,40].
10. Sustain global health security financing between outbreaks [44–47].
11. Integrate One Health surveillance into national preparedness plans [1,10–12].
12. Strengthen primary healthcare systems so routine services can continue during outbreaks [3,41,47].

CONCLUSION

Ebola virus disease remains a major emerging infectious disease threat with serious implications for public health, health systems, and global health security. Its epidemiology reflects the interaction between zoonotic spillover, environmental change, social determinants, healthcare capacity, and community trust. Effective prevention and control require rapid surveillance, laboratory diagnosis, contact tracing, infection prevention, safe burial practices, vaccination, treatment, and community engagement.

The experience of Ebola, especially the 2014–2016 West African epidemic, has transformed global thinking about outbreak preparedness. However, recurrent outbreaks show that continued investment is necessary. Future progress depends on stronger health systems, sustained global financing, One Health surveillance, equitable access to vaccines and therapeutics, survivor support, and trusted partnerships with affected communities. Ebola is not only a disease of the past; it remains a continuing warning that global health security depends on preparedness, equity, and cooperation.

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